Applying Evidence in Practice: A Qualitative Case Study of the Factors Affecting Residents' Decisions

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Patient care based on best available evidence is increasingly viewed as the hallmark of good quality medical diagnosis and treatment, yet its uptake is often slow and uneven and the reasons underlying the slow diffusion of evidence-based guidelines remain elusive. The authors report a qualitative study conducted at a major U.S. teaching hospital which sought to discover the reasons why an evidence-based anticoagulation guideline on appeared to be applied irregularly, with problematic results. Using a theoretical framework derived from Rogers' work on the diffusion of innovation, this paper describes the ways in which a group of residents evaluated and applied evidence in the context of caring for their patients. Future work in evidence-based practice can benefit from a greater emphasis on studies that use multi-method, qualitative designs to explore the complex ways in which people interact with information and the changes that ensue from its use.

Keywords
Diffusion of innovation, evidence-based practice, guideline adherence, organizational innovation

1. Introduction

In the years since Sackett's first book on evidence-based medicine (EBM) appeared, interest in EBM has remained high, yet uptake of evidence is often slow and uneven [1]. Efforts to bring evidence to practice has been the focus of numerous investigations summarized recently by Prior, Guerin and Grimmer-Somers [2]. Although they were able to draw few definitive conclusions from their review, they noted that additional research into environmental, organization and individual clinician factors is likely to be promising.

The Institute of Medicine has recommended developing and disseminating clinical guidelines and providing tools and systems to support their implementation [3]. Selecting the most urgent problems upon which to focus attention and resources requires balancing between choosing the most easily addressed of solvable problems and those with the greatest prevalence and risk. Venous thromboembolism is the cause of significant morbidity and mortality and evidence-based guidelines for managing anticoagulation therapy have been in place for some time [4, 5]. The existence of an evidence base and published guidelines, however, do not necessarily translate into application of evidence to practice, as has been noted previously [6-8]. Consequently, the anti-coagulant heparin management is the focus of many quality improvement efforts by national hospital accreditation organizations, patient safety groups and decision support activities at many institutions [9-11]. For
example, some healthcare organizations have implemented nurse-managed protocols, while others have harnessed informatics in the creation and deployment of decision support tools [12, 13]. Each of these solutions illustrates a different approach to ordering medications that require constant monitoring and adjustment several times a day, presenting a special complication of medication ordering and management.

Good systems design requires understanding work patterns and information flow in the clinical environment; effecting behavioral change at the organizational and individual level requires similar understanding of the barriers and facilitators to applying evidence in practice. The current paper is a case study using qualitative methods to explore the factors that affected internal medicine residents as they managed unfractionated heparin therapy during a period of rapid change in a complex environment. By turning to the residents themselves to learn how they coped with uncertainty, how they adapted an evidence-based guideline to fit their needs, and what influenced their behavior, this study illustrates how residents applied evidence and experience in response to the constraints of the organizational environment in which they cared for their patients. Methodologically, it suggests ways in which an in-depth study can contribute insights into the application of evidence to practice.

2. Theoretical Framework

Diffusion of innovation theory has been used to explain adoption patterns of a wide variety of healthcare innovations—both technological and behavioral—using studies evidence-based guidelines [15-18]. Initially proposed by Everett Rogers, the key elements in diffusion theory are: the innovation, the communication channel, the rate of adoption, and the social system (context and organizational environment). The five stages of the diffusion process are: knowledge, persuasion, decision, implementation, and confirmation. The rate of adoption is the relative speed with which members of a social system adopt an innovation; the presence of an opinion leader is seen as a factor in the rate of diffusion. The innovation itself also affects the decision to adopt or reject an innovation. These characteristics expressed in terms of a guideline are:

- Relative advantage over the current practice
- Compatibility with workflow
- The complexity (difficulty of use negatively affects adoption)
- Trialability (ability to try an innovation prior to adoption positively affects adoption)
- Observability (innovations visible to others are more likely to be adopted and spread)

Among the most influential reviews of diffusion theory in the healthcare sector are by Berwick [16] and Greenhalgh et al. [17], each has been cited over 400 times. Berwick identified three clusters of factors that that influenced the diffusion of innovation into practice: clinician perceptions of the innovation, the characteristics of the individual, and managerial factors within the organization. Greenhalgh et al. [17] stressed the importance of viewing diffusion from an ecological, process-oriented perspective that is multidisciplinary, multi-method and "meticulously detailed." While the extensive research program they laid out was beyond the scope and resources of this study, we adopted wherever possible their general orientation.

The features of diffusion theory that we examined in this study are the characteristics of the innovation—the guideline, the communication channels through which diffusion occurs, the context and organizational environment, the individuals who influence adoption decisions and the adoption action—adopt, modify, or reject. We then created an interview guide with semi-structured questions that addressed these aspects of our theoretical framework.

3. Setting

The study was conducted at a tertiary care, urban, academic medical center in the U.S. which is consistently rated among the best hospitals, is technologically advanced and academically rigorous. Thus, when reports from the Department of Pathology revealed an unacceptably high percentage of "critical action values" for activated partial thromboplastin times (aPTT) in patients receiving unfractionated heparin, steps were taken to address the problem (the aPTT is a test of blood clotting time used to monitor patients at risk for blood clots). The first step was a medical logic module (MLM) illustrated in Figure 1. Though initially encouraged by reports of similar devices, it was abandoned after concerns about the safety of its "closed loop" alert feature which was believed to be dysfunctional in the local environment [13]. As aPTT values continued to be unacceptably high, particularly in the
Internal medicine services where heparin is usually administered by house staff, it became imperative to explore other factors that might be contributing to the problem.

![Screenshot of MLM Heparin Order Initiation](image)

**Figure 1** Screenshot of MLM Heparin Order Initiation.

### 4. Method

We purposefully selected one of four groups of internal medicine residents who were responsible for managing anticoagulant therapy on the medicine service from which the critical action values originated. A strong sense of camaraderie develops among the residents who attend didactics together, make daily rounds, and take call for each other (the second year residents were excluded from the study because they were on rotation outside the hospital during the time of the study). The chief resident introduced the principal researcher to the residents prior to the beginning of the study.

We chose to employ qualitative methods—semi-structured interviews and field observations—because of their strength in providing rich description and their ability to reveal contextual factors [19-25]. To supplement and triangulate our interview data, one investigator (PWB) produced extensive field notes from observation on two similar units and from attending morning rounds over a period of several weeks. We examined laboratory reports and anticoagulation protocols from other units within the
hospital and conducted additional background interviews with stakeholders such as physicians, nurses, pharmacists, pathologists, and other laboratory personnel. These interviews yielded information about therapeutic anticoagulation practices elsewhere in the institution, familiarized us with the organizational culture of the nursing units and the medicine service, provided a comparative view of the workflow compared with that on other floors and in other services, and built important relationships by acquainting stakeholders with study objectives.

The haematologist on the team monitored aggregate lab data on out-of-range aPTT values during the study to confirm that critical action values continued to occur. The primary investigator (PWD) conducted the interviews and field observations. The other team members remained in constant contact with the team, reviewing the data as it emerged and offering additional interpretive comments.

The interview questions were pre-tested with recently graduated physicians who were unaffiliated with the internal medicine residency. The questions were revised, and submitted to the Institutional Review Board (IRB) as part of the study protocol. Modifications requested by the IRB were made prior to final approval.

Interviews took place on the unit during April and May 2007, usually right after morning rounds, and averaged 20 minutes in length. The chief resident was interviewed at the conclusion of the study. The subjects were orally consented at the time of the interviews which were digitally recorded, downloaded, anonymised and transcribed by the interviewer (PWD).

Residents were first asked to recall specific situations, “critical incidents” in which they had ordered therapeutic heparin for an inpatient on the medicine service [25, 26]. As might be expected, the critical incidents the residents described were frequently complex clinical situations. See Figure 2. This approach yielded stories that provided a rich context for understanding the residents’ experience and attitudes, revealing how the residents grappled with the challenges of medical practice. Such narratives have been increasingly found to yield valuable insights in both diffusion of innovation studies and in quality improvement research [27].

Because of our specific interest in information flow and decision support, the residents were also asked to identify wherever possible the source(s) of information they would consult when they had questions about heparin management. Follow-up questions asked residents to describe any problems they encountered in applying the heparin guideline. To learn more about the specific features that could be included in a clinical decision support (CDS) system, residents were shown the screenshot of the MLM (Figure 1) and asked to assess its potential utility. They were asked to comment on two key features: automatic calculation of dosage based on weight, and the alerting mechanism. The final question of the interview was open-ended to encourage additional comments about any aspect of the heparin management process—particular challenges, suggestions for changes, or general observations.

5. Analysis

The interviews were recorded, downloaded and transcribed verbatim. A codebook was developed to guide the coding of the transcripts against the topics identified in the diffusion theoretical framework. Each interview was read multiple times prior to the primary researcher’s coding of the transcripts. The first pass over the data extracted the key elements of the residents’ heparin dosing as reported in the critical incident: the initial infusion dose, whether it was weight-based, whether a bolus was ordered and how many adjustments were needed to reach goal. These data were provided to Hematology for their use. The second and subsequent passes analyzed the data in light of the theoretical framework and also to identify key themes. To ensure validity in the coding, the coding process for two variables — the communication channel and the innovation (the use of a weight-based bolus)—were reviewed by two other members of the research team (NKR and MBS). That is, the themes and their attribution to the variables were reviewed independently from the initial coding process; any discrepancies were discussed and resolved [28]. Multiple rounds of coding and analysis are common in qualitative research as the researcher becomes more immersed in the data and begins to identify themes that may not have been apparent initially [29].
Example A: Patient with nephrotic syndrome described by an intern
Well, last night I admitted a patient with...nephrotic syndrome which puts him at risk for pulmonary thrombosis and he was transferred from an outside hospital... So the guidelines say use 18, but I undershot at 15, and then when I did do his PTT about six hours later, he was within the therapeutic target range... I've had negative experiences in general with giving boluses. I think I can barely count the number of times I've been able to give bolus without greatly overshooting the PTT. [R104]

Example B: Patient with pulmonary embolism described by an intern
Yeah, a pulmonary embolism. I'll usually start with a bolus or a half bolus, in a patient who's smaller... so this was a kind of a bigger guy, so I started with a bolus, and I got it therapeutic pretty quickly and... right at the beginning I think I was checking PTT ratios every 4 hours with every scheduled lab draw and adjusting the rate based on that. In the Guide, there's a little chart. I'm not sure it's the best way to do it. But it usually seems to help me get therapeutic pretty quickly and it suggests when you should next check the PTT ratio. [R109]

Example C: Patient with coronary artery disease described by an intern
...so my last patient, who had a pretty significant history of coronary artery disease and seemed to have laboratory and EKG changes consistent with something that would indicate being started on therapeutic heparin... I think our handbook says anywhere from 16 to 18 and so I usually go anywhere from 14 to 16, sorry, and usually start at 14. IF I give them the bolus... I'm a little more conservative, I don't want to overshoot and ... I try not to over anticoagulate. [R106]

Example D: Patient with two pulmonary emboli being evaluated for cancer in the thigh, described by a senior resident
A lot of the interns use a kind of standard approach. When you use this though, and you do a bolus, and if you do exactly what they say to do here, I think at least half of the time, it's over shot and the levels are usually super therapeutic... I usually down play it a little bit. So whatever this came out to be, say, it came out to be a 5000 unit bolus, I would tend to do like a 3000 unit bolus. And then if it said to start the drip at 1000, I would usually start the drip at 800... if they needed to be therapeutic quickly with a PE or something, I'd bolus... to do the trick. But I usually underplay it a little bit based on the gold standard calculation. [R308]

Figure 2 Selected critical incidents.

6. Results

6.1 Diffusion theory: the guideline

In this study, the clinical guideline from the resident's manual constituted the innovation. Residents recognized that the guideline was evidence-based, and a few recalled its origins in the literature, but several others referred to guidelines taken from other institutions. Some reported trying to use the guideline, but abandoning it as they encountered difficulty in implementing it. Any authority that may have been attributed to the guideline because it was in the "official manual" did not take precedence over the residents' pragmatic approach to anticoagulation.

According to diffusion theory, a predictor of adoption of an innovation is its ability to be adapted to the user's environment. Innovations that can be adapted easily are more often adopted, and we found that the residents quickly began to modify the dosing guidelines to fit their experience. The following are typical comments:

...in the beginning, when I used the protocol, it never worked and then I found my own. [R103]
...everyone develops their own system; you have the template and develop from there. [R106]

Adoption is also affected by relative advantage over existing patterns of behaviour. In this study, the relative advantage afforded by the guideline was minimal and transient. It was available and
convenient to the residents because it was given to them at the beginning of their residency in a handy, portable format, but when residents followed the guideline, they found their patients’ aPTTs exceeded the target range. They then determined that they needed to adopt new approaches.

A related characteristic that affects adoption is compatibility. That is, an innovation may provide relative advantage but if it is inconvenient or its adoption is incompatible with workflow, it is less likely to be adopted. In this study, compatibility with the guideline revolved primarily around the difficulty of obtaining a blood draw. Although a team of phlebotomists was available to draw blood for the aPTT, the schedule was irregular and often unpredictable. Residents found that they had to consider this lack of predictability as they planned their patient care. When the phlebotomy team was unavailable to draw blood for testing, the residents used a number of work-arounds, as illustrated in these comments:

...you kind of have to time it...But I've learned a little trick, to order it STAT, and then they'll get it within a reasonable time. Sometimes it's hard to time it perfectly.

...it can be really hard to get it every, even eight hours, it can be a challenge. It's possible, but it can be very hard to get it...Too, we're not as good as the phlebotomists and so we often need to stick people multiple times, and it's very unpleasant for the patient.

The residents reported that the lab was responsive in sending results to the floor even when the resident was on another floor. Even though orders for dose adjustments can be entered from another unit using a computerized provider order entry (CPOE) system, residents reported feeling uncomfortable doing so. Each of these examples illustrates the impact of compatibility upon adoption.

6.2 Influence and communication channels

Residents reported that they occasionally consulted with haematology faculty on managing a difficult case, but the communication channels most used by residents were the senior residents and each other. Many residents named the senior resident as a source of information and counsel but as they gained more experience, they began to rely on their own judgment. The following comment from a senior resident is typical: "I think 90 per cent of my knowledge comes from trial and error and learning on my own, seeing patients and hearing word of mouth from my seniors." There was no mention of a clinical champion or opinion leader. Thus, the overall picture that emerges is of a tightly connected peer group sharing their growing experience with one another.

6.3 Organizational context and adoption decision

All but one of the residents initially used the guideline presented to them in their manual; one resident reported using one from another hospital because she felt it was more effective. They rarely continued to use it, however, because of the difficulty with blood draws and the perceived tendency of the guideline to result in over-coagulation that generated an alert. The tendency toward over-coagulation and the resulting alert require a filtration downward and another aPTT to determine whether the target blood level has been achieved. Because the phlebotomy schedule was unreliable, there was an incentive to "understand" in order to avoid an alert. The residents coped with this situation by adapting the guideline or abandoning it altogether. Nonetheless, the number of critical action values remained above the desired level set by the lab and the Haematology Department.

6.4 Information sources

Because of our particular interest in information sources, we asked residents to comment on the sources that they consulted when they had questions. Most residents used quick reference tools such as MICROMEDEX® (Thomson Reuters) and UptoDate (Walters Kluwer). One resident reported finding a new guideline in the Annals of Internal Medicine, which he adopted in preference to the guideline in the residents' manual.

6.5 Clinical decision support

During each interview, the researcher showed the residents a screenshot of the MLM, provided a brief explanation of intended purpose, and then asked residents to comment on its potential utility.
stated that the MLM would be fine as long as there was a choice as to the appropriate protocol and it could provide "a little guidance." Residents particularly desired a feature that would auto-populate fields such as current weight, last bolus and last infusion ordered, because this function provides a context for up-dating or changing the order. They expressed little need for the alerting feature, since they received alerts directly from the lab or indirectly through the nurses when an out-of-range lab value was received. Given the inherent problems with a closed loop alert system, this feature seemed to have little value and could potentially have a negative impact if the alert was not re-set during hand-off at the end of the shift.

6.6 Suggestions for improvement

The last question of each interview invited residents to "wave a magic wand" that would enable them to make any changes that they thought would enable them to manage anticoagulation therapy more effectively. Interview data indicated two desirable strategies to improve anticoagulation therapy: a nurse-managed protocol and using low molecular weight heparin. The residents rotated through units where nurse managed protocols were in place and had these comments:

...for a million reasons we wish that the nurses on all floors could draw labs and then put in IVs and I think if the nurses could draw labs, they could easily follow a heparin protocol and titration rates. [R101]

...the best system is the [one in which] the nurses are drawing the blood, and then you can just call and ask them and they can do it and if you're reasonable and give them a decent timeframe, then by far, that works the best. [R108]

Despite their enthusiasm for nurse-managed protocols, the residents also acknowledged that the nurse-patient ratio was beyond their ability to change. The presence of sufficient institutional resources to invest in innovation has been suggested as an important factor in institutional innovation, quality improvement and an incentive to implementation [17]. Recent experience of the Center for Innovations in Quality Patient Care also confirms that institutional commitment to innovation can result in measurable change [30].

Late in the study, one resident cited an American College of Physicians guideline published two months earlier that supported the use of low molecular weight heparin (LMWH enoxaparin Lovenox® sanofi-aventis) [31]. Lovenox is delivered subcutaneously and does not require blood draws and titration like unfractionated heparin—features which provided a distinct advantage to a busy resident. Following this "discovery," the resident abandoned the guideline in favour of LMWH. As he began to talk about its advantages, several other residents began to use it as well. The comments here reflect its perceived relative advantage over unfractionated heparin:

...I would try to find a reason to use Lovenox because we don't have to titrate that. [R113]

...I would much rather use Lovenox over heparin any day so I try to use Lovenox as much as possible. [R112]

As a result of this study, all heparin protocols in the institution were reviewed with a goal of reducing the number from 11 to 3. The new guideline for the medicine service reflects the new ACP guideline, and the insights gained through this investigation have enabled a more inclusive conversation that involves nursing and pharmacy. As indicated by the interviews with the residents, the initial bolus and infusion doses used on the weight-based protocol are being adjusted and a multidisciplinary group is re-visiting nurse-managed heparin protocols on the general medicine floors.

7. Discussion

Observers of clinician behaviour acknowledge that adoption of clinical guidelines is a complex process complicated by many barriers. Possible solutions to effecting behavioural change have been proposed from informatics (clinical decision support), policy (pay for performance), education, and legislation [32-35]. In this study, we sought to understand the barriers and incentives to applying evidence-based guidelines by directly engaging a group of residents as they made decisions regarding adoption, adaptation or rejection of the officially sanctioned evidence-based guideline presented to them. The problems the residents faced and their ways of coping with them in the messy, real world of clinical practice suggest that environmental and organizational factors may need to be considered when introducing guidelines that require behavioural changes, particularly those that are enhanced or
supported by technology [36]. Acquiring this level of understanding is especially important for non-clinicians such as information professionals and systems designers who are called upon to design systems to facilitate the application of evidence to practice.

We learned that in this instance, simply making the guideline available was not sufficient to change practice. The residents did not ignore the guideline because they did not appreciate the value of evidence-based practice, but any perceived authoritative advantage of the guideline was outweighed by the cost of using it. Once the residents became aware of an evidence-based approach that had high relative advantage and was compatible with their responsibilities and workflow, the diffusion was rapid and almost complete where clinically appropriate. Compared to the 17 year transit time of research to practice that is frequently cited, this represents an extraordinarily quick adoption [3]. This observation suggests that young physicians are open to innovation and value scientifically sound practice, but they seek to minimize perceived costs either to themselves or to their patients.

Residents continually faced trade-offs as they cared for their patients. Most adapted the guideline or rejected it altogether because, in their experience, both the initial, weight-based infusion rate and the bolus were “too high” or “too aggressive” and necessitated more titrations, which were viewed as costly either because they endanger their patients or they require additional time to infuse the dose. Furthermore, they did not want to depend on an unpredictable phlebotomy schedule. This finding suggests that an appreciation of how organizational context — particularly interdependencies among organizational units — affects clinical behaviour is essential to applying evidence in practice [18, 37]. Since the attitudes and behaviours learned during residency are likely to remain for many years afterward, the responses that these residents had to this guideline may be informative to those seeking to introduce guidelines in other comparable environments.

The residents’ comments about desirable features to include in future CDS systems provide useful insights for future development. Although not specifically mentioned, a “dashboard” display of data would appear to be a desirable feature. Taken together, these results illustrate the benefits of qualitative methods in understanding the implementation of guidelines, and can play an important part in assessing the need for certain informatics applications.

8. Limitations

As with any qualitative study, there were some limitations. We studied a group of residents over a short period of time in a particular, highly specialized environment. Although we captured input from all the residents who were on-site at the time and found consistency in their responses, our study remains a “snapshot in time.” A follow up study of residents using the new heparin protocol might yield different responses and generate different insights.

This study focused on one institution whose organizational and patient profiles differ substantially from a community hospital or an outpatient practice. The common features in residency experiences, however, suggest that repeating this study in a different academic environment might yield similarly useful insights into how guidelines are adopted or adapted in clinical practice.

The primary data collection and analysis was conducted by one person. However, results were reviewed by experts in haematology, informatics, and information science. The utility of the results, like those of most qualitative studies, lies in their ability to inform future investigations and implementations [22].

The length of the interviews with the residents was somewhat shorter than those in many qualitative studies; however, we chose to conduct the interviews on the units within the patient care context, believing that the responses would be more candid, more accurate, and more insightful. Also, our focus was very specific, which enabled us to more readily achieve saturation in our areas of interest.

9. Summary and conclusion

Diffusion and uptake of clinical guidelines has been erratic, slow, and in some cases, problematic. Typically, much of the interest in diffusion theory focuses on hastening adoption of specific innovations by targeted groups, using particular strategies such as identifying an internal champion or providing incentives [38, 39]. These approaches view diffusion of innovation instrumentally, rather than analytically, using the theoretical structure as a means to an end. When faced with the need to improve heparin management in a particular institution, we chose first to spend time in the environment, asking questions, listening carefully and then designing our response to meet the need.
In the process, we learned more about the barriers that can affect the implementation of any behavioural and organizational change, whether driven by introducing an evidence-based guideline or implementing a technological innovation.

Our experience supports the recent call for more in-depth analysis at the early stages of any proposed change and we believe that this approach will ultimately foster improvements in patient care [36]. Contemporary health care is in a state of constant change, whether stemming from policy changes, economic pressures, advances in scientific evidence or technological innovation. Identifying barriers and incentives to these changes is essential to their effective implementation. Because these barriers may differ across environments, adding qualitative data to other methods can direct attention where it is needed most, thereby conserving resources both human and technological. Not all organizations, and not all guidelines, are the same; it is therefore important to approach proposed changes openly, asking questions and carefully attending to the answers for what additional insight they may yield. This is true not only for evidence-based guidelines per se, but also for proposed technologies such as computerized decision support systems (CDSS).

Our particular interest in the implementation of evidence-based medicine leads us to suggest that future work in this area can benefit from a greater emphasis on multi-method, qualitative designs to explore the complex ways in which people interact with information and the changes that ensue from its use. Information alone is not sufficient to change practice, but evidence that is compatible with workflow and offers an advantage – particularly when it is introduced by trusted colleagues – is likely to be adopted and can be expected to make a difference in clinical practice. This study illustrates how qualitative methods aimed at eliciting and appreciating the complex, constructed nature of clinicians’ interactions with evidence can contribute to a richer understanding of information use in clinical practice and its effect on patient care.

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