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Clinical Questions Raised by Providers in the Care of Older Adults

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OBJECTIVE. To characterize clinical questions raised by providers in the care of complex older adults.

MATERIALS AND METHODS. To elicit clinical questions, we observed and audio-recorded outpatient visits at 3 health care organizations. At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. We observed 36 patient visits with 10 providers at the 3 study sites. Providers raised 70 clinical questions (1.9 clinical questions per patient seen), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. We propose a series of recommendations that may be used to guide the design of solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be variable across studies and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9]

Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) How do issues related to aging affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 health care providers from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[11] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to briefly summarize the case, listing the patient's problems, medications, and visit goals. At the end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the subject of the

question; and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also noted whether the question was pursued, whether it was answered (according to the provider), and which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified questions that were both explicitly stated by providers in the post-visit interview and inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[12] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison method.[13] In the first round, the four study authors independently proposed candidate factors for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus (one of the authors is an experienced geriatrician). In the second round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group

consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (1.9 questions per patient seen), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important for the patient's care. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer.

Types of clinical questions and aging factors

Table 1 shows the frequency of clinical questions according to Ely's taxonomy comparing to five previous studies that used the same taxonomy. Over one third of the questions were about

treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table 2). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table 2.

DISCUSSION

We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines,[4] which leads to significant deficits in the quality of care.[8 9 14] As a second strength, our method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in our study were left unanswered. These unanswered questions may contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14]

Consistent with previous studies, providers did not pursue over half of their questions, even though 81% of these questions were considered to be important for the patient's care. When providers pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer.

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table 3, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table 3 are technically feasible and international standards are available to enable automated links between EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community

clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. However, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2]

Future studies

Studies are needed to design and assess interventions that help providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Table 1. Clinical Questions Classified According to the Ely Taxonomy and Compared with Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Gorman, 1995	Ely, 1999	Gonzalez-Gonzalez, 2007	Graber, 2007	Ebell, 2011	Current study
What is the drug of choice for condition x?	13%	10%	7%	10%	13%	16%
What is the cause of symptom x?	3%	10%	20%	3%	6%	3%
How should I treat condition x (not limited to drug treatment)?	10%	6%	2%	5%	15%	8%
What is the cause of physical finding x?	2%	6%	15%	3%	3%	3%
What test is indicated in situation x?	9%	8%	3%	8%	6%	5%
What is the dose of drug x?	3%	8%	3%	13%	2%	4%
Can drug x cause (adverse) finding y?	6%	4%	1%	7%	8%	13%
What is the cause of test finding x?	4%	5%	3%	2%	5%	1%
Could this patient have condition x?	1%	4%	6%	1%	2%	1%
How should I manage condition x (not	2%	5%	4%	0.4%	1%	0%

specifying diagnostic or therapeutic)?						
What is the prognosis of condition x?	NA	NA	0.2%	4%	6%	1%
What are the manifestations of condition x?	NA	NA	1%	8%	2%	0%
What conditions or risk factors are associated with condition y?	NA	NA	1%	6%	1%	1%

* NA=Not available

Table 2 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these conditions would be less common in non-aging patients.	What is the best treatment choice for cognitive dysfunction?

Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for geriatric tool	1 (1%)	Need for tools (e.g., assessment tools) that are specific for geriatrics.	Where can I find a template for Hematology-Oncology assessment

No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table 3 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

	identification of how the provider addressed patient preferences, social support and functional status.	
Access to health services	Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.

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OBJECTIVE. To ~~assess the frequency with which providers raise, pursue, and answer~~characterize clinical questions raised by providers in the care of complex older adults.

MATERIALS AND METHODS. To elicit clinical questions, we ~~conducted patient care observations following the cognitive work analysis method. Ten health care providers and 36 patients were recruited from~~observed and audio-recorded outpatient ~~clinics~~visits at 3 health care organizations. ~~Patient care visits were observed and audio-recorded.~~ At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their ~~importance, urgency, and difficulty.~~ urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. ~~Thirty six~~We observed 36 patient visits ~~were observed~~ with 10 providers at the ~~three~~3 study sites. Providers raised 70 clinical questions (1.9 clinical questions per patient seen), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by ~~aging factors~~issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The ~~prevalence~~frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. ~~Our findings~~We propose a series of recommendations that may be used to guide the design of ~~interventions~~solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be ~~quite~~ variable across studies~~, ranging from~~ and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9] Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important~~, urgent,~~ to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) ~~what and how~~ How do issues related to aging ~~factors contribute to the nature of clinical~~affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 health care providers from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[11] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to briefly summarize the case, listing the patient's problems, medications, and visit goals. At the end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the subject of the

question; and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also noted whether the question was pursued, ~~the resources used, and~~ whether ~~the question~~it was answered (according to the provider), and which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified ~~both~~ questions that were both explicitly stated by providers in the post-visit interview and ~~those that were~~ inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[12] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison method.[13] In the first round, the four study authors independently proposed candidate factors for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus- (one of the authors is an experienced geriatrician). In the second

round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (1.9 questions per patient seen), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important~~.~~ for the patient's care. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer.

Types of clinical questions and aging factors

Table 1 shows the frequency of clinical questions according to Ely's taxonomy ~~compared~~comparing to five previous studies that used the same taxonomy. Over one third of the questions were about treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table 2). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table 2.

DISCUSSION

~~Based on a systematic review of clinicians' questions,~~We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines.[4] ~~Studies that evaluate the quality of care in older adults have found~~ which leads to significant deficits in the quality of care.[8 9 14] ~~Since most care for older adults is done by family practice physicians, the need to provide effective support for these providers' questions will increase. In~~ As a second strength, our ~~study, over half of the~~ method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in ~~the care of older adults~~our study were ~~not answered. Unanswered questions have been linked to suboptimal clinical decisions and lower quality of care. When~~left unanswered~~, the kinds of~~. These unanswered questions ~~found in our study~~ may

contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14] ~~Yet, most of these issues were found to be preventable.~~

~~When compared to studies that employed similar methodology, but not exclusive to older adults, our observed rate of clinical questions was on average three times higher (1.9 versus 0.6 questions per patient seen). Our findings are consistent with those by Norlin et al., who found a 1.7 times higher rate of questions in the care of children with special health care needs versus well-child visits. The higher rate observed in our study was likely due to the complexity of the patients observed as well as to aging factors.~~

Consistent with previous studies, providers did not pursue over half of their questions, even though ~~providers considered~~ 81% of ~~their~~these questions were considered to be important for the patient's care. When providers ~~decided to pursue their questions~~pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer. ~~Access to information at the time of the visit is important because providers rarely pursued questions after a patient's visit. Yet, in a health care environment where providers spend on average 15 minutes per patient visit, constraining information-seeking to the time frame of a patient encounter compromises clinicians' ability to find and apply external knowledge to their decisions. In addition, these patients were complex, requiring more than usual attention. Another potential solution is to design interventions that help providers record their questions and pursue these needs at their convenience, such as on follow-up with the patient or at the end of the day. References that answer these questions could be automatically stored in the patient's electronic health record (EHR) and also be applied in~~

~~similar situations. The general approach could be shared with other providers through technologies like social media. In addition, automated analysis of recorded questions could be integrated with providers' self-assessment for tailoring life-long learning as a component of Maintenance of Certification. This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.~~

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table 3, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table 3 are technically feasible and international standards are available to enable automated links between EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]~~These factors could be considered in the design of information resources, which could directly contrast treatment alternatives in light of aging-specific constraints, priorities and individual concerns. For example, EHR systems coupled with Information retrieval tools could provide dynamic displays that help providers quickly contrast the effectiveness, safety, and aging implications of treatment options for a given patient's condition. In addition, common questions could be anticipated by extracting patient-specific information that would make their care particularly complex. Finally, alternate sources of evidence based on just-in-time population analytics are being proposed and would be highly relevant in this population. One example of such an approach enables the comparison of treatments and outcomes in similar patients.~~

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is

required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. However, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2]

Future studies

Studies are needed to design and assess interventions that help ~~clinicians'~~providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger

adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Table 1. Clinical Questions Classified According to the Ely Taxonomy and Compared with Pooled Data from 5 Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Previous studies	Current study
What is the drug of choice for condition x?	10%	16%
What is the cause of symptom x?	10%	3%
How should I treat condition x (not limited to drug treatment)?	7%	8%
What is the cause of physical finding x?	7%	3%
What test is indicated in situation x?	6%	5%
What is the dose of drug x?	6%	4%
Can drug x cause (adverse) finding y?	5%	13%
What is the cause of test finding x?	4%	1%
Could this patient have condition x?	4%	1%
How should I manage condition x (not specifying diagnostic or therapeutic)?	4%	0%
What is the prognosis of condition x?	2%	1%
What are the manifestations of condition x?	2%	0%
What conditions or risk factors are associated with condition y?	2%	1%

Table 1. Clinical Questions Classified According to the Ely Taxonomy and Compared with Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Taxonomy code	Gorman, 1995	Ely, 1999	Gonzalez-Gonzalez, 2007	Graber, 2007	Ebell, 2011	Del Fiol, 2013
What is the drug of choice for condition x?	2.1.2.1	13%	10%	7%	10%	13%	16%
What is the cause of symptom x?	1.1.1.1	3%	10%	20%	3%	6%	3%
How should I treat condition x (not limited to drug treatment)?	2.2.1.1	10%	6%	2%	5%	15%	8%
What is the cause of physical finding x?	1.1.2.1	2%	6%	15%	3%	3%	3%
What test is indicated in situation x?	1.3.1.1	9%	8%	3%	8%	6%	5%
What is the dose of drug x?	2.1.1.2	3%	8%	3%	13%	2%	4%
Can drug x cause (adverse) finding y?	2.1.3.1	6%	4%	1%	7%	8%	13%

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~~What is the cause of test finding x?~~	~~1.1.3.1~~	~~4%~~	~~5%~~	~~3%~~	~~2%~~	~~5%~~	~~1%~~
~~Could this patient have condition x?~~	~~1.1.4.1~~	~~1%~~	~~4%~~	~~6%~~	~~1%~~	~~2%~~	~~1%~~
~~How should I manage condition x (not specifying diagnostic or therapeutic)?~~	~~3.1.1.1~~	~~2%~~	~~5%~~	~~4%~~	~~0.4%~~	~~1%~~	~~0%~~
~~What is the prognosis of condition x?~~	~~4.3.1.1~~	~~NA~~	~~NA~~	~~0.2%~~	~~4%~~	~~6%~~	~~1%~~
~~What are the manifestations of condition x?~~	~~1.2.1.1~~	~~NA~~	~~NA~~	~~1%~~	~~8%~~	~~2%~~	~~0%~~
~~What conditions or risk factors are associated with condition y?~~	~~4.2.1.1~~	~~NA~~	~~NA~~	~~1%~~	~~6%~~	~~1%~~	~~1%~~

~~* NA=Not available~~

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Table 2 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
~~Treatment choice~~Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
~~Managing~~Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these	What is the best treatment choice for cognitive dysfunction?

		conditions would be less common in non-aging patients.	
Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for	1 (1%)	Need for tools (e.g., assessment tools) that are specific	Where can I find a template for Hematology-

geriatric tool		for geriatrics.	Oncology assessment
No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table 3 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

Access to health services	identification of how the provider addressed patient preferences, social support and functional status. Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.

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Observations of Clinical Questions Raised by Providers in the Care of Older Adults

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OBJECTIVE. To characterize clinical questions raised by providers in the care of complex older adults in order to guide the design of interventions that help providers answer their questions.

MATERIALS AND METHODS. To elicit clinical questions, we observed and audio-recorded outpatient visits at 3 health care organizations. At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. We observed 36 patient visits with 10 providers at the 3 study sites. Providers raised 70 clinical questions (median of 2 clinical questions per patient seen; range 0 to 12), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. We propose a series of recommendations that may be used to guide the design of solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

1 STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be variable across studies and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9]

Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) How do issues related to aging affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 experienced geriatricians, family physicians, and nurse practitioners from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

We focused on clinical questions as defined by Ely et al.:[11] "questions about medical knowledge that could potentially be answered by general sources such as textbooks and journals, not questions about patient data that would be answered by the medical record." To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[12] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to briefly summarize the case, listing the patient's problems, medications, and visit goals. At the

end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the clinical domain of the question (e.g., treatment of depression); and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also observed whether the question was pursued, asked providers whether a satisfactory answer was found, and observed which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified questions that were both explicitly stated by providers in the post-visit interview and inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[11] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison method.[13] In the first round, the four study authors independently proposed candidate factors

for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus (one of the authors is an experienced geriatrician). In the second round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

Last, we conducted univariate analyses to test the association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue. Statistical significance was tested with the Fisher's Exact Test. We also assessed the association between number of questions per patient and number of questions pursued. Statistical significance was tested with ANOVA, with the binary decision to pursue as the grouping variable.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (average of 1.9 questions per patient seen; median of 2 questions per patient see; range 0 to 12 questions), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important for the patient's care. Of the questions that were left unanswered, 45% were considered to be important or very important and 8% were considered to be urgent or very urgent. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer. None of the associations between the independent variables (urgency, importance, provider confidence, and time pressure) and a question being pursued were significant (Table 1). Physicians were more likely to pursue questions for patients whose care generated a larger number of questions ($F(1,68) = 4.076$; $p = 0.047$).

Types of clinical questions and aging factors

Table 2 shows the frequency of clinical questions according to Ely's taxonomy comparing to five previous studies that used the same taxonomy. Over one third of the questions were about treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table 3). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table 3.

DISCUSSION

We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines,[4] which leads to significant deficits in the quality of care.[8 9 14] As a second strength, our method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in our study were left unanswered and providers rated close to half of these questions as important or very important for the patient's care. These unanswered questions may contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14]

Consistent with previous studies, providers did not pursue over half of their questions When providers pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer. Providers were more likely to pursue questions for patients whose care generated a larger number of questions. It is possible that these patients were more complex and therefore required more careful deliberation.

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table 4, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table 4 are technically feasible and international standards are available to enable automated links between

EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. To minimize this risk, we observed providers in their typical busy routine as unobtrusively as possible, and asked them to carry out their work as they would normally do. In addition, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2]

Future studies

Studies are needed to design and assess interventions that help providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such

as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Table 1. Association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue a clinical question.

Predictor	Fisher's Exact Test	Degrees of freedom	P-value
Urgency	0.54	1	0.64
Importance	0.37	1	0.65
Provider confidence	0.99	1	0.36
Time	2.2	1	0.34

Table 2. Clinical Questions Classified According to the Ely Taxonomy and Compared with Pooled Data from 5 Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Previous studies	Current study
What is the drug of choice for condition x?	10%	16%
What is the cause of symptom x?	10%	3%
How should I treat condition x (not limited to drug treatment)?	7%	8%
What is the cause of physical finding x?	7%	3%
What test is indicated in situation x?	6%	5%
What is the dose of drug x?	6%	4%
Can drug x cause (adverse) finding y?	5%	13%
What is the cause of test finding x?	4%	1%
Could this patient have condition x?	4%	1%
How should I manage condition x (not specifying diagnostic or therapeutic)?	4%	0%
What is the prognosis of condition x?	2%	1%
What are the manifestations of condition x?	2%	0%
What conditions or risk factors are associated with condition y?	2%	1%

Table 3 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these conditions would be less common in non-aging patients.	What is the best treatment choice for cognitive dysfunction?

Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for geriatric tool	1 (1%)	Need for tools (e.g., assessment tools) that are specific for geriatrics.	Where can I find a template for Hematology-Oncology assessment

No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table 4 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

	identification of how the provider addressed patient preferences, social support and functional status.	
Access to health services	Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.

Observations of Clinical Questions Raised by Providers in the Care of Older Adults

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OBJECTIVE. To characterize clinical questions raised by providers in the care of complex older adults in order to guide the design of interventions that help providers answer their questions.

MATERIALS AND METHODS. To elicit clinical questions, we observed and audio-recorded outpatient visits at 3 health care organizations. At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. We observed 36 patient visits with 10 providers at the 3 study sites. Providers raised 70 clinical questions (median of 2 ~~1.9~~ clinical questions per patient seen; range 0 to 12), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. We propose a series of recommendations that may be used to guide the design of solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

1

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be variable across studies and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9]

Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) How do issues related to aging affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 experienced geriatricians, family physicians, and nurse practitioners ~~health care providers~~ from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

We focused on clinical questions as defined by Ely et al.:[11] "questions about medical knowledge that could potentially be answered by general sources such as textbooks and journals, not questions about patient data that would be answered by the medical record." To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[12] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to

briefly summarize the case, listing the patient's problems, medications, and visit goals. At the end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the ~~subject~~ clinical domain of the question (e.g., treatment of depression); and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also ~~noted~~ observed whether the question was pursued, asked providers whether ~~it was~~ a satisfactory answer was found~~ed (according to the provider)~~, and observed which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified questions that were both explicitly stated by providers in the post-visit interview and inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[11] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison

method.[13] In the first round, the four study authors independently proposed candidate factors for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus (one of the authors is an experienced geriatrician). In the second round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

Last, we conducted univariate analyses to test the association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue. Statistical significance was tested with the Fisher's Exact Test. We also assessed the association between number of questions per patient and number of questions pursued. Statistical significance was tested with ANOVA, with the binary decision to pursue as the grouping variable.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (average of 1.9 questions per patient seen; median of 2 questions per patient see; range 0 to 12 questions), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important for the patient's care. Of the questions that were left unanswered, 45% were considered to be important or very important and 8% were considered to be urgent or very urgent. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer. None of the associations between the independent variables (urgency, importance, provider confidence, and time pressure) and a question being pursued were significant (Table 1). Physicians were more likely to pursue questions for patients whose care generated a larger number of questions ($F(1,68) = 4.076$; $p = 0.047$).

Types of clinical questions and aging factors

Table ~~1~~ 2 shows the frequency of clinical questions according to Ely's taxonomy comparing to five previous studies that used the same taxonomy. Over one third of the questions were about treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table ~~2~~3). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table ~~2~~3.

DISCUSSION

We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines,[4] which leads to significant deficits in the quality of care.[8 9 14] As a second strength, our method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in our study were left unanswered and providers rated close to half of these questions as important or very important for the patient's care. These unanswered questions may contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14]

Consistent with previous studies, providers did not pursue over half of their questions~~, even though 81% of these questions were considered to be important for the patient's care.~~ When providers pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer. Providers were more likely to pursue questions for patients whose care generated a larger number of questions. It is possible that these patients were more complex and therefore required more careful deliberation.

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table ~~3~~4, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table ~~3~~ 4 are technically feasible and international standards are available to enable automated links between

EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. To minimize this risk, we observed providers in their typical busy routine as unobtrusively as possible, and asked them to carry out their work as they would normally do. ~~However~~In addition, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2]

Future studies

Studies are needed to design and assess interventions that help providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such

as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Author contributions: GDF provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) drafting the article; and 3) final approval of the version to be published. AIW provided 1) substantial contributions to acquisition of data and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CPB provided 1) substantial contributions to analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CRW provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published.

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Table 1. Association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue a clinical question.

Predictor	Fisher's Exact Test	Degrees of freedom	P-value
Urgency	0.54	1	0.64
Importance	0.37	1	0.65
Provider confidence	0.99	1	0.36
Time	2.2	1	0.34

Table 2~~1~~. Clinical Questions Classified According to the Ely Taxonomy and Compared with Pooled Data from 5 Previous Studies.

The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Previous studies	Current study
What is the drug of choice for condition x?	10%	16%
What is the cause of symptom x?	10%	3%
How should I treat condition x (not limited to drug treatment)?	7%	8%
What is the cause of physical finding x?	7%	3%
What test is indicated in situation x?	6%	5%
What is the dose of drug x?	6%	4%
Can drug x cause (adverse) finding y?	5%	13%
What is the cause of test finding x?	4%	1%
Could this patient have condition x?	4%	1%
How should I manage condition x (not specifying diagnostic or therapeutic)?	4%	0%
What is the prognosis of condition x?	2%	1%
What are the manifestations of condition x?	2%	0%
What conditions or risk factors are associated with condition y?	2%	1%

Table ~~2~~ 3 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these conditions would be less common in non-aging patients.	What is the best treatment choice for cognitive dysfunction?

Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for geriatric tool	1 (1%)	Need for tools (e.g., assessment tools) that are specific for geriatrics.	Where can I find a template for Hematology-Oncology assessment

No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table ~~3~~ 4 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

	identification of how the provider addressed patient preferences, social support and functional status.	
Access to health services	Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.

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Clinical Questions Raised by Providers in the Care of Older Adults: A Prospective Observational Study

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OBJECTIVE. To characterize clinical questions raised by providers in the care of complex older adults in order to guide the design of interventions that help providers answer their questions.

MATERIALS AND METHODS. To elicit clinical questions, we observed and audio-recorded outpatient visits at 3 health care organizations. At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. We observed 36 patient visits with 10 providers at the 3 study sites. Providers raised 70 clinical questions (median of 2 clinical questions per patient seen; range 0 to 12), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. We propose a series of recommendations that may be used to guide the design of solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be variable across studies and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9]

Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) How do issues related to aging affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 experienced geriatricians, family physicians, and nurse practitioners from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

We focused on clinical questions as defined by Ely et al.:[11] "questions about medical knowledge that could potentially be answered by general sources such as textbooks and journals, not questions about patient data that would be answered by the medical record." To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[12] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to briefly summarize the case, listing the patient's problems, medications, and visit goals. At the

end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the clinical domain of the question (e.g., treatment of depression); and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also observed whether the question was pursued, asked providers whether a satisfactory answer was found, and observed which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified questions that were both explicitly stated by providers in the post-visit interview and inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[11] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison method.[13] In the first round, the four study authors independently proposed candidate factors

for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus (one of the authors is an experienced geriatrician). In the second round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

Last, we conducted univariate analyses to test the association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue. Statistical significance was tested with the Fisher's Exact Test. We also assessed the association between number of questions per patient and number of questions pursued. Statistical significance was tested with ANOVA, with the binary decision to pursue as the grouping variable.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (average of 1.9 questions per patient seen; median of 2 questions per patient see; range 0 to 12 questions), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important for the patient's care. Of the questions that were left unanswered, 45% were considered to be important or very important and 8% were considered to be urgent or very urgent. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer. None of the associations between the independent variables (urgency, importance, provider confidence, and time pressure) and a question being pursued were significant (Table 1). Physicians were more likely to pursue questions for patients whose care generated a larger number of questions ($F(1,68) = 4.076$; $p = 0.047$).

Types of clinical questions and aging factors

Table 2 shows the frequency of clinical questions according to Ely's taxonomy comparing to five previous studies that used the same taxonomy. Over one third of the questions were about treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table 3). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table 3.

DISCUSSION

We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines,[4] which leads to significant deficits in the quality of care.[8 9 14] As a second strength, our method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in our study were left unanswered and providers rated close to half of these questions as important or very important for the patient's care. These unanswered questions may contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14]

Consistent with previous studies, providers did not pursue over half of their questions When providers pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer. Providers were more likely to pursue questions for patients whose care generated a larger number of questions. It is possible that these patients were more complex and therefore required more careful deliberation.

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table 4, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table 4 are technically feasible and international standards are available to enable automated links between

EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. To minimize this risk, we observed providers in their typical busy routine as unobtrusively as possible, and asked them to carry out their work as they would normally do. In addition, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2] Finally, the four-week time frame for follow-up may have introduced recall bias, as in previous studies most providers pursued their clinical questions within 24 hours of a patient encounter.[2]

Future studies

Studies are needed to design and assess interventions that help providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse

effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Author contributions: GDF provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) drafting the article; and 3) final approval of the version to be published. AIW provided 1) substantial contributions to acquisition of data and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CPB provided 1) substantial contributions to analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CRW provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published.

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Table 1. Association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue a clinical question.

Predictor	Fisher's Exact Test	Degrees of freedom	P-value
Urgency	0.54	1	0.64
Importance	0.37	1	0.65
Provider confidence	0.99	1	0.36
Time	2.2	1	0.34

Table 2. Clinical Questions Classified According to the Ely Taxonomy and Compared with Pooled Data from 5 Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Previous studies	Current study
What is the drug of choice for condition x?	10%	16%
What is the cause of symptom x?	10%	3%
How should I treat condition x (not limited to drug treatment)?	7%	8%
What is the cause of physical finding x?	7%	3%
What test is indicated in situation x?	6%	5%
What is the dose of drug x?	6%	4%
Can drug x cause (adverse) finding y?	5%	13%
What is the cause of test finding x?	4%	1%
Could this patient have condition x?	4%	1%
How should I manage condition x (not specifying diagnostic or therapeutic)?	4%	0%
What is the prognosis of condition x?	2%	1%
What are the manifestations of condition x?	2%	0%
What conditions or risk factors are associated with condition y?	2%	1%

Table 3 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these conditions would be less common in non-aging patients.	What is the best treatment choice for cognitive dysfunction?

Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for geriatric tool	1 (1%)	Need for tools (e.g., assessment tools) that are specific for geriatrics.	Where can I find a template for Hematology-Oncology assessment

No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table 4 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

	identification of how the provider addressed patient preferences, social support and functional status.	
Access to health services	Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.

~~Observations of~~ Clinical Questions Raised by Providers in the Care of Older Adults: A Prospective Observational Study

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OBJECTIVE. To characterize clinical questions raised by providers in the care of complex older adults in order to guide the design of interventions that help providers answer their questions.

MATERIALS AND METHODS. To elicit clinical questions, we observed and audio-recorded outpatient visits at 3 health care organizations. At the end of each appointment providers were asked to identify clinical questions raised in the visit. Providers rated their questions regarding their urgency, importance to the patient's care, and difficulty to finding a useful answer. Transcripts of the audio-recordings were analyzed to identify aging-specific factors that may contribute to the nature of questions.

RESULTS. We observed 36 patient visits with 10 providers at the 3 study sites. Providers raised 70 clinical questions (median of 2 clinical questions per patient seen; range 0 to 12), pursued 50 (71%) and successfully answered 34 (68%) of the questions they pursued. Overall, 36 (51%) of providers' questions were not answered. Over one third of the questions were about treatment alternatives and adverse effects. All but 2 clinical questions were motivated either directly or indirectly by issues related to aging, such as the normal physiologic changes of aging and diseases with higher prevalence in the elderly.

CONCLUSION. The frequency of clinical questions was higher than in previous studies conducted in general primary care patient populations. Clinical questions were predominantly influenced by aging-related issues. We propose a series of recommendations that may be used to guide the design of solutions to help providers answer their clinical questions in the care of older adults.

Key words: Clinical Decision-making; Complex Patients; Health Care Quality; Older Adults

1

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths:

- First study to observe clinical questions in the care of complex older adults.
- Our method included direct audio-recorded observations of providers in multiple phases of outpatient care. This method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall.
- The study findings raise important implications to improve the design of online health knowledge resources and electronic health record systems.

Limitations:

- Direct comparisons of question frequencies were not possible because we did not observe clinical questions in non-aging and non-complex patients.
- The small number of sites and providers in each subgroup precluded a comparison of questions between different setting types and provider types.

INTRODUCTION

In a seminal study, Covell *et al*. observed that physicians raised two questions for every three patients seen in an outpatient setting.[1] In 70% of the cases, these questions were not answered. More recent research has produced similar results, with little improvement in the three decades since Covell's study was published. According to a systematic review, estimates ranged from 0.2 to 1.9 clinical questions per patient seen, with less than half of these needs being pursued, and over 60% of questions not being answered.[2] Unanswered clinical questions may represent knowledge gaps that have been associated with errors and reduced quality of care.[3] This problem may be aggravated by the increasing volume of medical knowledge and patient complexity, especially associated with the aging population.[4-6]

The number of older adults in our society is increasing dramatically as the "Baby Boomers" start to age. In addition, the number of geriatricians available to care for them is not keeping pace with the increase. In fact, family physicians provide the majority of care for older adults[7] making education of these providers an important component of any program to improve the quality of care. Caring for older adults is complex. Recent reviews assessing the quality of care provided for older adults have found significant deficits. For example, researchers found that only half of the vulnerable elderly living in the community received care that met quality indicators and only a third received care for those conditions that primarily impact the elderly.[8] In another recent review, Askari and authors (2011) found rates of appropriate care to be variable across studies and very low for many geriatric-related conditions, including dementia (11%-35%), depression (27%-41%), and osteoporosis (34%-43%).[9]

Despite substantial previous research on providers' clinical questions, little is known about the specific characteristics of questions that arise in the care of aging and complex patients.

Knowledge of clinical questions in this patient population may be used to guide the design of interventions that help providers answer their questions and improve the care of older patients. The overall aim of this study was to address this gap. Specifically, we aimed at answering the following study questions: 1) How frequently do providers raise, pursue, and answer their clinical questions? 2) How urgent, important to the patient's care, and difficult to finding an answer are these clinical questions? 3) What types of questions are most commonly raised? 4) How often are these questions specific to geriatrics? 5) How do issues related to aging affect these questions?

METHODS

Study subjects and sites

All study subjects reviewed and signed an informed consent to participate in the study. We recruited 10 experienced geriatricians, family physicians, and nurse practitioners from outpatient settings at 3 health care organizations located in Utah: a geriatric clinic at the University of Utah, a geriatric clinic at the Salt Lake City Veterans Administration Medical Center (VAMC), and a community clinic at Intermountain Healthcare (Intermountain). We asked providers to identify complex patients who were scheduled for a visit during a typical clinic day. Complex patients were defined according to the Agency for Health Research and Quality (AHRQ) definition as those with "two or more chronic conditions where each condition may influence the care of the other condition(s) through limitations of life expectancy, interactions between drug therapies, and/or direct contraindications to therapy for one condition by other conditions themselves."[10]

Observations

We focused on clinical questions as defined by Ely et al.:[11] "questions about medical knowledge that could potentially be answered by general sources such as textbooks and journals, not questions about patient data that would be answered by the medical record." To elicit clinical questions, we conducted patient care observations following the cognitive work analysis method, which is a group of techniques that integrate observation and interview for the purposes of understanding the constraints, resources, behavior and cognitive goals of a work situation.[12] A researcher (AW) observed and audio-recorded providers in all activities related to a patient visit, including preparing for the visits (e.g., reviewing the patient's chart), interacting with the patient, and concluding the visit (e.g., documentation, medication prescription). Providers were asked to briefly summarize the case, listing the patient's problems, medications, and visit goals. At the

end of each appointment, providers were interviewed regarding the clinical questions that were raised in the visit. For each question identified, we asked the provider to rate its importance and urgency; level of confidence in the clinical domain of the question (e.g., treatment of depression); and the level of difficulty to find an answer. These measures were obtained using a Likert scale format for the questionnaire. We also observed whether the question was pursued, asked providers whether a satisfactory answer was found, and observed which information resources were used to answer it. The researcher contacted providers for a follow-up interview about questions that were not answered in the visit within four weeks following the observation session.

Data analysis

Audio-recordings were transcribed and de-identified for analysis. Two investigators (GDF, CRW) independently reviewed the transcripts to identify clinical questions. We identified questions that were both explicitly stated by providers in the post-visit interview and inferred from providers' verbalizations and observed information-seeking behavior. Next, annotations were compared assisted by the researcher who conducted the observations and discrepancies were resolved by discussion until the investigators reached consensus. The final set of questions was coded independently by two investigators (GDF, AW) according to the Ely's taxonomy of clinical questions.[11] In this phase, disagreements were also resolved by consensus.

Clinical questions were also coded in terms of the degree to which aging-related factors contributed to a question. An aging factor was defined as a patient characteristic that is exclusive to, or more common in, aging patients and that motivates or modifies the nature of a clinical question. Factors were identified and questions were coded using the constant comparison method.[13] In the first round, the four study authors independently proposed candidate factors

for a subset of 20 questions. Next, the factors proposed by each investigator were reconciled through group consensus (one of the authors is an experienced geriatrician). In the second round, investigators used the set of reconciled factors to code another set of 35 questions. In this round, new factors were proposed and the definition of previous factors was refined through group consensus. In the third and final round, investigators coded the remaining questions resolving disagreements by consensus. No changes to the factors were necessary in this final round.

Last, we conducted univariate analyses to test the association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue. Statistical significance was tested with the Fisher's Exact Test. We also assessed the association between number of questions per patient and number of questions pursued. Statistical significance was tested with ANOVA, with the binary decision to pursue as the grouping variable.

This study was approved by the University of Utah Institutional Review Board under study number 00051227 and Intermountain IRB study number RMS1024116.

RESULTS

Frequency of clinical questions raised, pursued, and answered

Providers raised 70 clinical questions in 36 patient visits (average of 1.9 questions per patient seen; median of 2 questions per patient see; range 0 to 12 questions), pursued 50 (71%), and successfully answered 34 (68%) of the questions they pursued. Most questions were pursued during the visit versus the follow-up period (48 versus 2 out of 50 questions pursued). Overall, 36 (51%) of providers' clinical questions were not answered.

Importance, urgency, confidence, and difficulty

Providers considered 42% (mean rating = 3.0; 1=not urgent; 5=very urgent) of their questions to be urgent or very urgent; and 81% (mean rating = 4.1; 1=not important; 5=very important) to be important or very important for the patient's care. Of the questions that were left unanswered, 45% were considered to be important or very important and 8% were considered to be urgent or very urgent. In 61% of the questions (mean rating = 3.8; 1=not confident; 5=very confident), providers felt that they were confident or very confident regarding their overall knowledge in the domain of the question. Providers perceived that only 14% (mean rating = 2.2; 1=not difficult; 5=very difficult) of the questions they pursued were difficult or very difficult to finding an answer. None of the associations between the independent variables (urgency, importance, provider confidence, and time pressure) and a question being pursued were significant (Table 1). Physicians were more likely to pursue questions for patients whose care generated a larger number of questions ($F(1,68) = 4.076$; $p = 0.047$).

Types of clinical questions and aging factors

Table 2 shows the frequency of clinical questions according to Ely's taxonomy comparing to five previous studies that used the same taxonomy. Over one third of the questions were about treatment alternatives and adverse effects. Most questions (68 out of 70; 97%) were directly or indirectly related to one of 10 aging-specific factors (Table 3). Over half (40; 57%) of the clinical questions were related to treatment factors, specifically *treatment choice* (18; 26%), *prescribing considerations* (13; 19%), and *managing side effects* (9; 13%). Table 3 proposes a set of recommendations to guide the design of online knowledge resources and electronic health record systems in light of the aging factors listed in Table 3.

DISCUSSION

We characterized the clinical questions raised by providers in the care of complex older adults. We found that providers raised 3 times more questions (1.9 versus 0.6 questions per patient seen) than in previous studies not focused on complex aging patients. This higher rate of questions may be attributed both to the complexity of patients seen and to aging factors. We also identified a set of aging-specific factors that motivated or affected most of the questions. These factors can be used to guide the design of solutions that can answer these questions more directly.

Our study has a few important strengths. This is the first study to observe clinical questions in the care of complex older adults. Investigating these questions is important because the aging population is rapidly increasing[5] and elderly patients with multiple co-morbidities are more difficult to manage with available clinical practice guidelines,[4] which leads to significant deficits in the quality of care.[8 9 14] As a second strength, our method included direct audio-recorded observations of providers in multiple phases of outpatient care. Most previous studies elicited clinical questions in after-visit interviews or relied on providers to keep their own record of their questions.[2] Our method allows more detailed and accurate data collection, since it relies on direct observations of care as opposed to provider's recall, which could involve a possible bias.

Over half of the questions raised in our study were left unanswered and providers rated close to half of these questions as important or very important for the patient's care. These unanswered questions may contribute to issues that disproportionally affect the elderly population, such as increased adverse events,[6 15-20] inappropriate medication prescription, treatment failure, and adverse drug withdrawal events.[14]

Consistent with previous studies, providers did not pursue over half of their questions When providers pursued a question they were successful most of the time. This might be an indication that providers self-select questions that can be answered with little effort. In our study, providers perceived that only 14% of the questions pursued were difficult to answer. Providers were more likely to pursue questions for patients whose care generated a larger number of questions. It is possible that these patients were more complex and therefore required more careful deliberation.

Compared to previous studies, we found a higher frequency of questions related to treatment alternatives and adverse effects. This finding could be explained by the presence of aging-specific factors that motivated or affected nearly all questions observed in our study. These factors commonly constrain or alter treatment choices, making treatment decisions more complex and often not amenable to available evidence-based guidelines.[4] This is consistent with a study by Merten et al., which found the inability to apply existing knowledge to a new and complex situation to be an important contributor to adverse events in older patients.[18] Providers in our study were often faced with the need to personalize treatment goals according to individual factors, such as undesired effects of treatment, co-morbidities, patients' priorities, and life expectancy. As healthcare delivery systems strive to provide patient-centered care, the need to personalize and integrate patient's specific context will become increasingly important.

Potential solutions

As suggested in Table 4, aging-specific factors should be considered in the design of online knowledge resources and EHR systems. The design considerations provided in Table 4 are technically feasible and international standards are available to enable automated links between

EHR systems and online knowledge resources.[21] These standards are being widely adopted in the United States as a requirement for EHR certification.[22]

Since providers rarely pursue questions after a patient's visit, solutions need to provide answers to providers' questions rapidly, ideally in less than a minute. Yet, in a health care environment where providers spend on average 15 minutes per patient visit,[23 24] constraining information-seeking to the time frame of a patient encounter may limit providers to pursuing easier questions. One alternative is to design interventions that help providers record their questions and pursue them at their convenience. Answers to these questions could be automatically stored in the patient's electronic health record (EHR) and shared with other providers who manage similar patients through technologies like social media and recommender systems. In addition, automated analysis of recorded questions could be used to help providers define their life-long learning goals as a component of Maintenance of Certification.[25 26] This form of self-directed learning could be more effective and compatible with the adult learning style than traditional forms of continuing medical education.[26 27]

Online knowledge resources could be designed to go beyond reporting of individual studies, but to supporting simulations of combinations of complex variables. A high level of integration is required in order to individualize or tailor treatment, but few single studies address any specific combination of risk, patient preferences, expected life expectancy and co-morbidities. This requirement is not needed in the older population, but also in other areas, such as children with special needs, immigrant populations and other unique populations.

Limitations

We did not observe clinical questions in non-aging and non-complex patients. Therefore, direct comparisons of question frequencies were not possible. The small number of sites and providers in each subgroup, along with the presence of several potential confounders, precluded a comparison of questions between different setting types (e.g., academic versus community clinic) and provider types (e.g., family physicians versus geriatricians, nurse practitioners versus physicians). As in previous similar studies, the presence of an observer may have stimulated questions and information-seeking behavior. To minimize this risk, we observed providers in their typical busy routine as unobtrusively as possible, and asked them to carry out their work as they would normally do. In addition, observation studies have provided more reliable results than other methods, such as self-report and surveys, which are prone to recall bias.[2] Finally, the four-week time frame for follow-up may have introduced recall bias, as in previous studies most providers pursued their clinical questions within 24 hours of a patient encounter.[2]

Future studies

Studies are needed to design and assess interventions that help providers' decision-making in aging and complex patients. As suggested in the previous sections, our findings provide important insights for intervention design. Moreover, larger studies are needed to enable subgroup comparisons such as the ones described above.

CONCLUSION

We found that providers raised a large number of clinical questions in the care of complex older adults and half of these questions were not answered. Compared to previous studies in younger adults, clinical questions in the care of the older population were raised three times more often. We also found a relatively higher rate of questions related to treatment alternatives and adverse

effects. Most of the questions were motivated or mediated by factors specific to aging. When unanswered, these questions may contribute to issues that are more prevalent in the elderly, such as an increased rate of adverse drug events. Our findings may be used to help guide the design of information delivery interventions that help providers answer their clinical questions in the care of older adults.

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Author contributions: GDF provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) drafting the article; and 3) final approval of the version to be published. AIW provided 1) substantial contributions to acquisition of data and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CPB provided 1) substantial contributions to analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published. CRW provided 1) substantial contributions to conception and design, and analysis and interpretation of data; 2) revising the article critically for important intellectual content; and 3) final approval of the version to be published.

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Table 1. Association between urgency, importance, provider confidence, and time pressure as predictors for the decision to pursue a clinical question.

Predictor	Fisher's Exact Test	Degrees of freedom	P-value
Urgency	0.54	1	0.64
Importance	0.37	1	0.65
Provider confidence	0.99	1	0.36
Time	2.2	1	0.34

Table 2. Clinical Questions Classified According to the Ely Taxonomy and Compared with Pooled Data from 5 Previous Studies. The Data Include the 13 Most Frequent Question Types that Accounted for 80% of the Questions Asked Across Studies.

Question type	Previous studies	Current study
What is the drug of choice for condition x?	10%	16%
What is the cause of symptom x?	10%	3%
How should I treat condition x (not limited to drug treatment)?	7%	8%
What is the cause of physical finding x?	7%	3%
What test is indicated in situation x?	6%	5%
What is the dose of drug x?	6%	4%
Can drug x cause (adverse) finding y?	5%	13%
What is the cause of test finding x?	4%	1%
Could this patient have condition x?	4%	1%
How should I manage condition x (not specifying diagnostic or therapeutic)?	4%	0%
What is the prognosis of condition x?	2%	1%
What are the manifestations of condition x?	2%	0%
What conditions or risk factors are associated with condition y?	2%	1%

Table 3 – Frequency of Clinical Questions per Aging Factor.

Aging factor	Frequency	Definition	Examples
Special considerations when choosing optimal treatment	18 (26%)	Selection of an optimal individualized treatment considering aging factors such as risk/benefit and co-morbidities. Successful outcome is more difficult because of underlying aging issues.	What is the preferred A1c goal in the aging population? What is the best treatment choice for diabetes when the patient also has heart failure?
Special prescribing considerations	13 (19%)	Medication prescription needs to be adjusted to maximize compliance, and minimize side effects / organ damage (e.g., by adjusting medication dose).	What is the geriatric dose of buspar for depression? What is the CrCl cutoff for alendronate?
Complex management of side effects	9 (13%)	Consideration of side effects. Issues such as polypharmacy and lower medication tolerance contribute to a higher incidence of and more complexity in managing side effects.	Is hallucination a side effect of rivastigmine? Is there adjunct treatment of depression that does not cause drowsiness?
Condition prevalence	8 (11%)	Condition related to the questions is much more prevalent in the elderly. Questions related to these conditions would be less common in non-aging patients.	What is the best treatment choice for cognitive dysfunction?

Understanding other provider's rationale	6 (9%)	Unable to interpret rationale of other providers due to lack of enough information (e.g., prescription without reason, diagnosis without explanation). Complex aging patients are often cared for by multiple providers.	What are these eye drops used for? What are the indications of concomitant use of aspirin and warfarin?
Dx testing considerations	4 (6%)	Aging risk factors need to be considered in the choice of diagnostic intervention.	Is contrast indicated for chest X-ray to assess aspiration in a patient with GERD?
Access to health services	4 (6%)	Health services that are more commonly needed or that have special requirements in elderly patients.	Where should I refer this patient for mental health?
Difficult diagnosis	4 (6%)	Difficult diagnosis due to underlying aging factors (e.g., multiple co-morbidities, different presentation). Difficult to interpret new set of symptoms/signs/findings in light of the overall patient's picture.	Why is this patient osteopenic? What is the cause of this patient's weight loss?
Gender considerations	1 (1%)	Decisions in the elderly that are affected by gender (e.g., different statin dose, different osteoporosis treatment)	How do I manage cardiovascular risk in elderly women?
Need for geriatric tool	1 (1%)	Need for tools (e.g., assessment tools) that are specific for geriatrics.	Where can I find a template for Hematology-Oncology assessment

No aging factor	2 (3%)	Question not motivated or mediated by aging and answer is not aging- specific.	Where can I find patient education information on cholesterol diet?

Table 4 – Aging factors and implications for the design of online knowledge resources and electronic health record (EHR) systems.

Aging factor	Implications for design	Examples
Special considerations when choosing optimal treatment and diagnostic testing.	Online knowledge resources could provide specific recommendations to help providers tailor treatment and choose diagnostic tests considering aging issues such as risk/benefit, co-morbidities, functional status, and social support. These recommendations should be easily accessible/filtered by the resource's search engine based on the patient's age. EHR systems should capture patient's life goals and integrate them into the patient's treatment plan.	"What is the preferred A1c goal in the aging population?" Provide recommendations on how to adjust the A1c goal given factors such as the patient's age, preferences, and life expectancy. "What is the best treatment choice for diabetes when the patient also has heart failure?" Provide treatment recommendations in the presence of most common co-morbidities.
Special prescribing considerations	Online knowledge resources could provide seamless access to age-specific guidance on dose adjustment, adherence issues in older adults, and aging-specific contraindications. EHR systems could propose and automatically calculate adjusted medication dosing when indicated	"What is the geriatric dose of buspar for depression?" Allow the user to provide the patient's age in the search process and highlight the geriatric dose in the user interface. When prescribing a medication or reviewing a patient's medications list, display an icon next to a medication that is potentially inappropriate for aging

	due to aging factors.	patients. Hovering the mouse over this icon provides an explanation and an suggested alternative.
Complex management of side effects	Based on a patient's side effect and current medications, online resources could provide likely side effects for combinations of medications often seen in older patients. Online resources could automatically construct a side effect profile based on the medications documented on the patient's EHR. In addition, online resource could enable providers to simulate alternate medication scenarios and compare side effect profiles of alternate scenarios.	"Which of the patient's medication may be causing hallucination?" Rather than scanning the list of side effects for each of the patient's current medications, EHRs could automatically send the side effect and the patient's medications list to online knowledge resources, which would return a table with the medications and their likelihood of causing the side effect of interest.
Understanding other provider's rationale	Providers should be able to document the rationale for their decisions (e.g., prescribing a medication, discontinuing a medication, ordering a diagnostic test) in the patient's EHR and link the rationale to the decision. This documentation should support	"What are the indications of concomitant use of aspirin and warfarin?" When hovering over a medication in the patient's medication list, the EHR shows the rationale of the prescriber for prescribing the medication.

	identification of how the provider addressed patient preferences, social support and functional status.	
Access to health services	Based on a location of interest and the patient's age, the EHR could automatically link to information on health services available in the area.	"Where should I refer this patient for mental health?" A link from the EHR could automatically retrieve mental health facilities within the patient's location.