Knowledge on inpatient diabetes among fourth year medical students

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Abstract:

Background: The importance of proper management of inpatient hyperglycemia is increasingly being recognized. However, the curriculum for 4th year medical students has lagged behind current clinical recommendations. The aim of this study is to assess the baseline knowledge of medical sub-interns on inpatient diabetes.

Methods: In the 2005-2006 school-year, sub-interns were given a pre-test on inpatient diabetes. Descriptive analysis was used.

Results: Students frequently recommended the sole use of sliding scale as management of diabetes. Hyperglycemia in patients not known to have diabetes is less likely to be recognized. The students were more likely to give appropriate management for chest pain than diabetes. Students otherwise had a good fund of knowledge about the recognition of the type of diabetes and the pharmacology of the medications.

Conclusion: This study demonstrates the gaps in knowledge about inpatient diabetes that exist prior to internship and residency. The findings can be used to design a curriculum appropriately targeted to the level of 4th year medical students.
Introduction:

Inpatient diabetes causes significant morbidity, mortality, cost and length of stay. It is often neglected since the majority of patients with diabetes are admitted for medical conditions other than diabetes. In the past decade, observational studies demonstrated increased morbidity, mortality, cost and length of hospital stay in hyperglycemic patients, while interventional studies in the intensive care setting showed that tight glucose control improves these outcomes. Consequently there is a movement to improve glycemic control in patients admitted to the hospital, whether they have newly recognized hyperglycemia or known diabetes. Published guidelines for inpatient management are a product of this movement and they emphasize proper insulin administration. However, up until 2004, a national medical curriculum for sub-interns (4th year medical students) still promoted the “ability to develop a sliding scale plan for inpatients” as a major learning objective (http://www.im.org/AAIM/Tools/docs/Curriculum/SubICurriculum2004/TableofContents.htm).

Consequently, we are targeting a program on the management of inpatient diabetes for 4th year medical students. As future house officers, they are at the frontline of inpatient diabetes management, yet most residencies apart from Internal Medicine and Pediatrics do not emphasize this topic. This study was undertaken to assess the baseline knowledge of medical sub-interns on inpatient diabetes. In so doing, we could re-examine the 4th year medical student curriculum and design one that is more appropriately targeted to their level. This would hopefully prompt other institutions to do the same with their sub-internship program, if they have not yet done so.

Methods:

The study was conducted at the University of Florida, Gainesville, FL. During the 2005-2006 academic year, sub-interns rotating each month in Internal Medicine were asked to complete a pre-test which included cases and questions on the recognition and management of inpatient diabetes. The pre-test comprised six question sets: two were case scenarios with open-ended questions as described below, and the remaining four were multiple choice and matching-type questions. The open-ended question sets were designed to be broad, encompassing not only diabetes but also the management of other medical conditions such as hypertension, chest pain, and chronic obstructive pulmonary disease in hospitalized patients in order to minimize bias that could occur if students recognized that diabetes knowledge was the area of interest. The students were not restricted on how to obtain the proper responses and they were given at least two days to complete the pre-test.

The two clinical scenarios consisted of patients presenting to the hospital with a problem unrelated to diabetes but who also had diabetic issues. Students were asked to identify the major medical problems (one of which was diabetes in each case) and generate an initial plan for the treatment of each of the identified problems. Case Scenario 1 was a 50 year old female admitted because of left-sided chest pain with exertion, with a history of type 2 diabetes and hypertension. She was on low-dose Amaryl and lisinopril, and was on metformin at maximum dose. On exam, she was hypertensive and obese. Serum
Creatinine was 1.8 mg/dL. The students were provided with pre-meal and bedtime inpatient capillary blood glucose levels (mg/dL) for the past 2 days ranging from 177-300.

Briefly, Case Scenario 2 was a patient with exacerbation of chronic obstructive pulmonary disease (COPD), on chronic intermittent steroid intake, with a history of HTN, and no previous diagnosis of diabetes. He was given high-dose steroids and had an elevated random plasma glucose in the hospital. Three additional capillary blood glucose (CBGs) taken pre-meals and at bedtime, ranging from 180 to 270 mg/dL, were subsequently provided to the students. The students were then asked to give new plans based on these.

The next four multiple-choice and matching-type questions assessed students’ fund of knowledge and covered hyperglycemia management during hospitalization, the time profiles of the different kinds of insulin, mechanism of action of oral medications, and recognition and initial management of type 1 versus type 2 diabetes.

Responses to the pre-test were collected during the second week of the rotation. One adult endocrinologist debriefed the students during a one-hour, primarily didactic teaching session about inpatient diabetes. This study was approved by our institutional review board.

At this tertiary academic medical center, all students are required to complete a one month sub-internship in Internal Medicine, Pediatrics, or Family Medicine. During their Pediatrics rotation, they have a one-hour case conference on endocrinology, with one of the cases being new-onset type1 DM. During their Family Medicine rotation, they have 2 hours of case conference on diabetes; students are told that sliding scale insulin is an antiquated approach to the management of DM. Approximately two-thirds of each class selects the Internal Medicine sub-internship, which is entirely inpatient and experiential. Inpatient diabetes teaching is largely dependent on the attendings assigned to the Internal Medicine teams. There are 3 General Internal Medicine services, 2 Hospitalist services, and several sub-specialty services (e.g. Cardiology, Hematology-Oncology). Three Adult Endocrinologists serve as attendings for a combined total of 4 months per schoolyear on one of the General Internal Medicine teams, during which time the sub-interns rotating with them receive a more detailed teaching of inpatient diabetes. Otherwise, most of the students’ exposure to inpatient diabetes is limited to cursory discussions on adjusting insulin doses on the general medical floors. Students are evaluated solely by their ward teams using a competency-based evaluation form with descriptive anchors. There is no written exam (except for the pre-test described above). Students are expected to manage a similar number of patients as an intern and are responsible for writing all patients order under the close supervision of a junior or senior resident who also co-signs the orders.

Our a priori hypotheses were: 1) that sole sliding scale insulin would be the most common treatment plan for diabetes, and 2) that newly detected hyperglycemia will not be recognized as a problem as often as previously diagnosed diabetes, and that 3) sub-interns are more familiar with the initial management of an acute problem such as chest pain rather than the inpatient management of diabetes, which is considered a chronic disease. Responses were de-identified. The pre-test was developed by the authors (one of whom is a General Internal Medicine physician and Master Educator, and the other an Adult
Endocrinologist) after assessing existing practices in the hospital through chart reviews and our extensive interactions with the housestaff. Other disease states such as hypertension, obesity, and renal dysfunction were added so that the true focus of the pre-test will be masked from the students. The Master Educator ensured that the questions were appropriate for the level of the sub-interns. Appropriateness of the treatment plans was determined by a consensus between the authors prior to tabulation of results, and was based on clinical experience and review of the literature. Chi-square was used for statistical analysis.

Results:

Fifty-two sub-interns completed the pre-test. For the open-ended clinical scenarios, all students (52/52) identified a known diagnosis of diabetes as a problem, whereas only 47/52 students recognized hyperglycemia in a patient without known diabetes as a problem (p = 0.025). The number of students who identified the other problems correctly for Case Scenario 1, as well as those who gave the appropriate initial management, is shown in Table 1.

Compared to the other medical conditions such as chest pain or hypertension, students were less apt to give appropriate management for diabetes. Seventeen out of 52 students wrote inappropriate initial management plans, including 16 who wrote for insulin sliding scale alone, and 1 who increased the dose of metformin. Ten of 52 students recognized the need to initiate a long-acting or intermediate-acting form of insulin, 8/52 either increased the glimepiride dose or added another oral hypoglycemic agent, and 17/52 suggested insulin as a therapy but did not specify the type. Interestingly, when subsequently asked to write out their orders for managing this hypothetical patient’s diabetes, 11 of the 36 students who did not initially suggest sliding scale insulin actually wrote down an insulin sliding scale as sole pharmacologic management instead of their previous answers. In addition, only 9 of the 52 students recognized the need to stop the metformin because of an elevated creatinine level.

Appropriate initial management was given more commonly for chest pain than for diabetes (see Table 1; p<0.001). For chest pain, the following were considered appropriate (with the number of responders in parentheses; total appropriate answer n=52 out of 52 students): obtain an EKG or cardiac enzymes (n=10), obtain an EKG and cardiac enzymes (n=35), administer nitroglycerin (n=2), stress test if the patient is stable (n=5). For hypertension, the following were considered appropriate (n=50 out of 52): add a beta-blocker (n=19), add a diuretic (n=11), increase lisinopril (n=16), add another anti-hypertensive medication (no medication specified; n=3), low-sodium diet (n=1). Two students simply said to continue the current medication, which we considered inappropriate since they did not specify that they wanted a re-check of the blood pressure. For obesity, 43 out of 44 students responded appropriately, recommending education or counseling on weight loss and exercise (n=32), and prescribing dietary modifications (n=11). One answered inappropriately, suggesting to simply monitor for fluid retention. For the elevated creatinine levels, 43 out of 51 gave appropriate recommendations, including: obtaining a full basic metabolic panel or at least BUN (n=12), comparing first with previous creatinine levels (n=11),
repeating creatinine levels or calculating creatinine clearance (n=10), discontinuing metformin (n=5), checking a urinalysis (n=2), giving fluids if the calculations show pre-renal problems (n=2), increasing ACE-inhibition for renoprotection (n=1), and monitoring input and output (n=1). The following was considered inappropriate: administering fluids (without checking to see if this is pre-renal; n=7).

In Case Scenario 2 (patient without known diabetes), the predominant management also consisted of sliding scale insulin alone, even after indicating that the patient subsequently had 3 more elevated glucose levels (See Table 2).

Students scored an average of 81% on the multiple-choice and matching-type questions that assessed fund of knowledge about the recognition of the type of diabetes and the pharmacology of the medications. However, students scored markedly lower on the one multiple-choice question that addressed management of hyperglycemia with only 4% answering correctly and 46% incorrectly selected sliding scale insulin as the best treatment plan.

Responses did not differ between students rotating early versus late in their 4th year in terms of prescribing sliding scale as the sole initial management for the patient in Case Scenario 1 (7 out of 25 in the earlier groups and 9 out of 27 in the later groups; p = NS).

Discussion:

Our study demonstrates the gaps in knowledge about inpatient diabetes that exist prior to internship and residency. Most striking is the inappropriate use of sliding scale insulin without scheduled insulin. The other major finding is that students fail to apply theoretical knowledge into practice (for example, they know the time profile of the different insulins yet cannot translate that into meaningful order entries). Other less striking, but notable knowledge gaps include failure to recognize hyperglycemia as a problem in patients without a previous diagnosis of diabetes, and failure to recognize medication contraindications. Students were able to make more appropriate recommendations for other medical problems such as chest pain, which supports a need for targeted education about diabetes.

Diabetes is a common inpatient diagnosis. In 2004, about 20% of hospitalized adult patients at UF & Shands had a diagnosis of diabetes, with probably 5% more being undiagnosed based on the literature (1-3). Inpatient hyperglycemia increases inpatient morbidity, mortality, length and cost of hospital stay (4-6), yet is frequently left unattended since it is usually not the patients’ chief complaint (3, 7). Because of the compelling evidence for better glycemic control in the hospital, guidelines for target blood glucose levels have been released, aiming for pre-prandial glucose levels of 110 mg/dL and maximal glucose levels of 180 mg/dL in non-critical care units (2).

A major finding in this study is that the over-use of sliding scale insulin already exists during sub-internship. Even though the source of the students’ knowledge was not formally tested, frequent interactions with them reveal that this is most likely handed down by interns, residents, and attendings. In one study at our tertiary academic medical center, a common cause of inpatient hyperglycemia was the sole use of sliding scale to manage the patients’ diabetes (8). The sliding scale method has been shown in several studies to be ineffective (9, 10),
yet this practice has been passed down over decades. Moreover, insulin is a common source of medication error (11, 12), and proper education is needed to prescribe the proper kind and dose. However, re-education on this topic has been challenging. One study on educating housestaff on the use of proactive insulin treatment instead of regular insulin sliding scale did not meet with success (13). Lately, one method that was more effective required one endocrinologist to round with two residents twice a day, at 7 a.m. and 6 p.m., for two weeks at a time (14). Though the effort is admirable, not all programs have the necessary dedicated faculty members to carry out this task. Moreover, it seems logical that this teaching should be done earlier – at the time of the medical students’ exposure to the hospital wards – before these would-be interns start taking care of their own patients.

The recognition that diabetes is a problem is important for resource allocation and proper management. In a study comparing diagnoses of hospitalized patients, the diagnosis of diabetes was omitted in anywhere from 47% to 88% of discharge diagnoses (15). The percentage of admissions and bed occupancy accounted for by diabetic patients was underestimated – only half of the diabetic patients admitted were coded as such. In another study of hospitalized patients hyperglycemia but no previous diagnosis of diabetes, 66% of the progress notes failed to mention either diabetes or hyperglycemia as a problem (3). In our study, all of the students recognized diabetes as a problem when the diagnosis was given to them, but not necessarily so when presented with a hyperglycemic patient without known diabetes. Even in this test setting where students were prompted to list 5 medical problems, they still failed to recognize hyperglycemia more often than any other problem except obesity (which arguably is not an acute hospital problem). This is consistent with the underrecognition of diabetes and hyperglycemia in the hospital setting and makes it a clear target for future educational interventions.

The students have a good fund of theoretical knowledge, with most of them being familiar with the time action profile of insulin and mechanism of action of oral medications. However, most of them are still unable to translate this into practice – most of them still chose to prescribe sliding scale insulin in different case scenarios. The sub-internship is one of the first times in medical training that students are given independent (though supervised) responsibility for patient care. This makes these application deficits more apparent but also the 4th year an ideal time to promote education about patient management.

Until the beginning of 2005, the sub-intern curriculum set by the Alliance for Academic Internal Medicine included, as a learning objective for inpatient diabetes, the development of a sliding scale plan for the patients (http://www.im.org/AAIM/Tools/Docs/Curriculum/SubICurriculum2004/TableofContents.htm). This clearly lagged behind the recommendations of experts to institute basal and nutritional insulin for inpatient glycemic control (2, 16). Diabetes was also considered a chronic condition whose management was left in the outpatient realm. In the second half of 2005, the learning objectives for the sub-intern curriculum were revised; sliding scales were supplanted by the need to address basal and nutritional insulin requirements. The management of diabetes in the hospital was given more
attention and not relegated only to the outpatient setting.

We acknowledge the fact that our study was done in a non-clinical setting, i.e. students were asked to answer questions presented in a test format rather than analyzing patients that they have seen, and this might affect construct-validity. However, we attempted to present them with scenarios that resemble true inpatient cases. The students were also just in their first week of internal medicine rotation, and could potentially have learned appropriate diabetes inpatient management in the succeeding weeks. However, we know from our extensive interactions with housestaff that this is not likely to occur without formal teaching. We addressed content-validity by including several aspects of inpatient diabetes knowledge, including mechanism of action of oral medications, action profiles of different insulins, and formulation of treatment plans, with more emphasis on the latter since the medical students are in their clinical rotations at this stage. However, this pre-test was not intended to be exhaustive, but was meant to touch on the more common situations the sub-interns were going to encounter.

Another limitation is that our study was performed with a small sample size and in a single institution in Florida, such that our results may not be generalizable. However, we know from our contacts with colleagues during national meetings, that our experience is not unique to us. Our study might prompt a more systematic evaluation of other institutions’ curricula for sub-interns.

We believe that inpatient diabetes management is appropriately taught earlier than internship and residency. This study has provided us with baseline information that can be used for our educational program for sub-interns.
REFERENCES


Table 1. Number of students who identified the medical problems and gave an appropriate initial plan in Case Scenario 1.

<table>
<thead>
<tr>
<th></th>
<th>N correctly identified as problem (%)</th>
<th>N gave appropriate initial plan (%)</th>
<th>p value (appropriate initial plan compared to diabetes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>52/52 (100)</td>
<td>35/52 (67)*</td>
<td>--</td>
</tr>
<tr>
<td>Chest pain</td>
<td>52/52 (100)</td>
<td>52/52 (100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>52/52 (100)</td>
<td>50/52 (96)</td>
<td>0.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>44/52 (85)</td>
<td>43/44 (98)</td>
<td>0.001</td>
</tr>
<tr>
<td>Elevated creatinine</td>
<td>51/52 (98)</td>
<td>43/51 (84)</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

- *decreased to 24/52 (46) when given more blood glucose readings
Table 2. Management for Case Scenario 2, before and after 3 more hyperglycemic values were provided.

<table>
<thead>
<tr>
<th>Management plan</th>
<th>Initial management</th>
<th>Management after 3 more hyperglycemic values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 47)</td>
<td>(n = 52)</td>
</tr>
<tr>
<td>Sliding scale alone</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>Long- or intermediate-acting insulin, with or without mealtime insulin</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Oral agents</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Obtain more glucose values</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>No answer</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Others (diet, unspecified insulin, taper steroids)</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>