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Concise Communication

Antimicrobial stewardship: The influence of behavioral nudging on renal-function–based appropriateness of dosing

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Abstract

Failure to adjust doses may contribute to adverse events. We evaluated the effectiveness of providing the estimated glomerular filtration rate on appropriateness of dosing for antimicrobials. The approach increased appropriateness of dosing from 33.9% to 41.4% ($P < .001$). Nudging prescription behavior can boost strategies for adequate antimicrobial prescription.

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Prescribing an adequate dosage of medication is important for therapeutic safety and efficacy, due to the accumulation of drugs and their metabolites. Renal function can be inferred through the estimated glomerular filtration rate (eGFR).[1] This information should be available and, ideally, easily accessible to physicians at the point of care. The current wide availability of electronic health record (EHR) systems, which provide clinical decision support through computerized physician order entry (CPOE), can increase the safety of prescriptions. Although it is common knowledge that antibiotic dosage must be adjusted according to renal function, prescribing renal function-based dosage is still a challenge due to poor awareness and adherence to recommendations.

Providing eGFR data to physicians could lead to an increase in renal-function–based dosage adjustments.[2,3] Although such an intervention would seem reasonable, its impact on the adequacy of medication prescriptions is unclear. Thus, we evaluated the influence of providing eGFR data through the CPOE to physicians on appropriateness of dosing rate for parenteral antimicrobials.

Methods

The Hospital de Clínicas de Porto Alegre is an 845-bed public university hospital in Porto Alegre, southern Brazil. In a quasi-experimental study, we assessed the impact of providing eGFR data in the CPOE of our institution's EHR (AGHUse).

The intervention consisted of inserting a window in the CPOE with the patient's eGFR data based on the last available serum creatinine measurement (Fig. 1). Before the intervention, the eGFR information had to be accessed by actively clicking (4 clicks) on the system, a task that required ~15–20 seconds. The primary end point of the study was the appropriateness of dosing for β-lactam antibiotic prescriptions.

The rate of renal-function–based appropriateness of dosing for four intravenous β-lactam antibiotics (cefuroxime, amoxicillin+clavulanate, cefepime and meropenem) were analyzed before (May–November 2016) and after (May–November 2017) eGFR data began to be included in the antibiotic prescription order (April 27, 2017). We chose to study antibiotics for which appropriateness of dosing relies mostly on renal adjustment, and we selected the most prescribed β-lactams at our institution. We included the entire adult inpatient population.

The Hospital de Clínicas de Porto Alegre Institutional Review Board approved the study (GPPG 18-0211/Plataforma Brasil, CAAE: 872367180.0000.5327).

Results

Over the study period, 58,465 prescriptions for amoxicillin+clavulanate, cefuroxime, meropenem, and cefepime were made for adult inpatients. Regarding the population with eGFR >60 mL/min, we retrieved 20,683 antibiotic orders before and 15,720 after the intervention period, and we noticed rates of appropriateness of dosing of 20,164 of 20,683 (97.5%) versus 15,322 of 15,720 (97.5%), for before versus after the intervention, respectively ($P = .91$). After excluding prescriptions for patients whose eGFR were not available prior to antimicrobial administration and those with eGFR >60 mL/min, 6,647 and 5,683 prescriptions remained before and after the intervention, respectively.

The appropriateness of dosing rates for patients with compromised renal function increased from 33.9% before the intervention to 41.4% after the intervention ($P < .001$).

Appropriateness of dosing rates for those with eGFR <60 mL/min increased for all antimicrobials, for before versus

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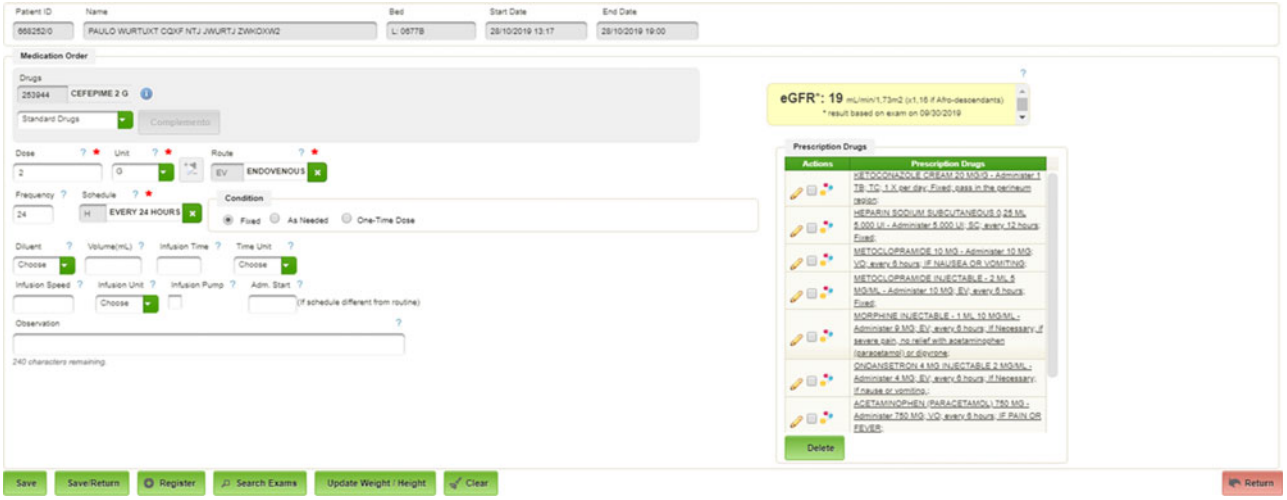

Fig. 1. The intervention consisted of inserting a window in the computerized physician order entry with the patient's estimated glomerular filtration rate (eGFR) based on the last available serum creatinine measurement.

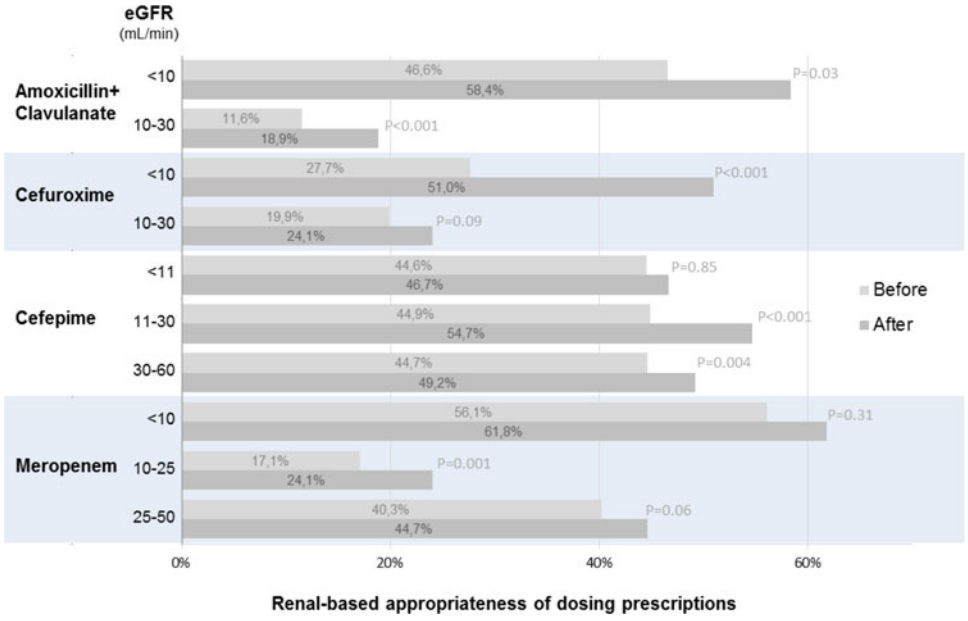

Fig. 2. Appropriateness of dosing rates, before and after the provision of the estimated glomerular filtration rate (eGFR) at the computerized physician order entry (CPOE), according to different eGFR ranges. * χ^2 tests were used for comparisons, and *P* values < .05 were considered statistically significant.

after periods, respectively, as follows: amoxicillin+clavulanate from 18.1% to 27.4% ($P < .001$); cefuroxime from 21.5% to 29.6% ($P < .001$); cefepime from 44.7% to 50.3% ($P < .001$); and meropenem from 31.6% to 39.2% ($P < .001$). The subanalysis of each antimicrobial according to eGFR range of adjustment is depicted in Figure 2.

Discussion

Appropriate hospital antibiotic use is a key element in patient safety. Up to 50% of the antibiotics prescribed in hospitals are inappropriate. An Australian survey found that 14% of the prescribed doses were inappropriate and that when creatinine levels were >120 μmol/L, the odds ratio of an inappropriate prescription was 3.4.[4] Our hospital has had an established antimicrobial stewardship program since the early 2000s. This program is based on formulary restriction, preauthorization, and postprescription prospective audit with feedback to prescribers of most antibiotics, including those investigated in the present study.

Interventions to improve antimicrobial prescriptions vary according to guidelines, but the complexity of the healthcare system requires actions that are flexible and creative and go beyond the traditional measures to improve patient antibiotic prescription. The 'low-hanging fruits' nudge strategy for antibiotic prescription favors some antibiotic classes or a specific choice for a certain infection.[5] This approach requires fewer resources by the stewardship team and less cognitive effort by the prescriber and can yield financial savings and affect resistance and patient care.

Beta-lactams are eliminated primarily through the kidney and have a large therapeutic window,[6] which could be one of the reasons for the small initial effect on appropriateness of dosing at the beginning of therapy. Due to their wide safety margins, perhaps renal adjustments are deferred until renal stabilization or antimicrobial levels are increased at the beginning of therapy (ie, the loading dose).

Behavior changes require a multimodal approach, with interventions that encompasses cognitive, behavioral, motivational and managerial aspects to promote the desired results.[7,8] Our

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hospital does not set routines for renal-function-based dosage appropriateness. Although antibiotic dose appropriateness requires a deliberate, conscious, and complex cognitive system, the strategy resulted in significant changes in antimicrobial prescriptions that favored patient safety.[9]

The relevant strengths of this study included the large number of prescriptions and the simplicity of the intervention, which lends itself to reproducibility. However, the study has several limitations. In some situations, eGFR data do not reflect the degree of renal dysfunction. Secondly, outcomes such as morbidity, mortality, hospitalization costs, or other potential impacts of renal-function–based dosage adjustments were not addressed in this study. Finally, a more powerful intervention might involve a tool that automatically suggests the default dose for each antimicrobial according to the patient's eGFR, evolving to provide active decision-making support.[10]

A simple change in the EHR layout for physicians who prescribed antimicrobials affected the rate of β-lactam appropriateness of dosing according to the latest eGFR data. Within an established antimicrobial stewardship program, behavioral nudging can boost strategies for more adequate drug prescription.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2020.253

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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