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Impact of a Clinical Decision Support System on Prescribing of Renally Cleared Drugs

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Abstract

The age-related decline in kidney (renal) function is poorly recognised by doctors prescribing renally cleared drugs in the elderly. This causes inadvertent overdosing of renally cleared drugs, increasing the incidence of adverse drug events. A clinical decision support system (GFR+) was developed for calculation of renal function and doses of key drugs adjusted for both weight and renal function. We examined the rate of appropriate prescribing for key renally cleared drugs before and after GFR+ implementation.

Improvements were seen in appropriate dosing of enoxaparin (from 68% to 86%, p=0.03), gentamicin (63% to 87%, p=0.01) and vancomycin (47% to 87%, p=0.07). More appropriate use of therapeutic drug monitoring for gentamicin (70% to 90%, p=0.0)3 and vancomycin (61% to 84%, p=0.17 was noted. With-holding renally cleared drugs during episodes of acute renal failure (43% to 64%, p=0.13) in creased, as did the frequency that frusemide was held (19% versus 31%, p<0.01). GFR+ improved prescribing habits of key renally cleared drugs in an elderly hospitalised population. This is expected to improve patient safety and outcomes in this susceptible group.

Keywords:

dosing, clinical decision support, drug safety, adverse drug reaction

Introduction

Adjusting doses of renally cleared drugs for renal function is an essential element of prescribing. Renal function declines slowly with age, but this is poorly recognised by doctors. The subsequent lack of dose adjustment leads to inadvertent overdosing in older patients, and an excess of adverse drug events, some of which are life-threatening[1]. The occurrence of an adverse drug event is associated with a two-fold increase in mortality rate, increased length of hospital stay of 1.91 days, and an extra US$2262 per patient[6]. Non-compliance for renal drug dosing within the hospital setting is common, with inappropriate prescribing in 19-67% of patients and this is often driven by over-reliance of serum creatinine as a marker of renal function, which is misleading in the elderly[2].

Renal function estimation, with a view to drug dosing, is not a reflex part of clinical practice for most clinicians. Lack of recognition of those drugs that are renally cleared may contribute to poor prescribing, along with the continuing reliance by some clinicians on serum creatinine as a quick guide to renal function in the elderly. Clinicians can easily be misled by normal-range serum creatinine measurements for elderly patients, which can mask significant renal decline. A serum creatinine of 100micromol/l is generally considered to be in the normal range, but results in vastly lower renal function estimations when applied to elderly patients. An 80 year old, 160cm, 45kg female with a serum creatinine of 100micromol/L has an estimated renal function of only 28ml/min, clearly necessitating adjustment of renally cleared drugs.

Methods

An integrated clinical decision support system (GFR+) was developed for the hospital inpatient setting (Figure 1). Functions included automatic renal function estimates, and development and incorporation of sophisticated dosing algorithms, including dose adjustment for renal function, weight and obesity. The module was linked through local databases to enable automatic input of required variables. Serum creatinine values were updated automatically as they became available. GFR+ was designed as a stand-alone module, outside of normal workflow, as electronic prescribing is not available at this hospital. Prescribers were under no obligation to utilize GFR+. Data were collected for 5 months pre- and post-intervention to assess the impact of GFR+ on appropriate prescribing of renally cleared drugs within the hospital setting. The focus was on several critical drugs with a low therapeutic index (gentamicin, enoxaparin and vancomycin), and whether appropriate drug management action was taken during episodes of acute renal failure. GFR+, along with key messages on prescribing issues surrounding renally cleared drugs was introduced using an academic detailing approach.

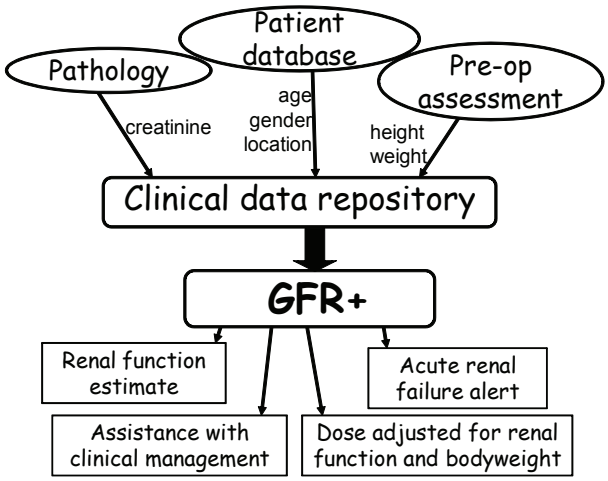


Figure 1

Results

Patient characteristics across the two groups were similar with the following exceptions: pre-intervention patients had better renal function, were less likely to be on frusemide as part of drug management, and more likely to receive gentamicin or vancomycin as part of their drug management during hospitalisation.

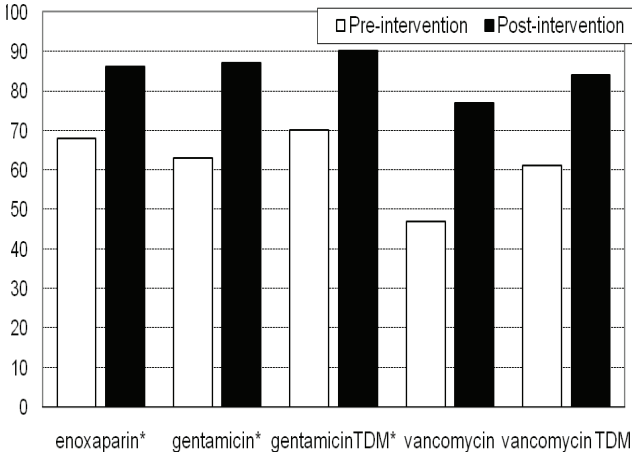
Table 1

	Pre-intervention	Post-intervention
N	509	492
No. of males	292	300
Age (y)	77.9 ± 11.2	78.6 ± 12.4
Weight (kg)	73.9 ± 17.8	72.7 ± 19.9
Length of stay (d)	7 (1-154)	7 (1-84)
Co-morbidities (median, range)	3 (0-12)	3 (0-9)
Renal function * (ml/min)	47.4 + 24.1	43.3 + 22.7
Acute renal failure	24	16
ACE Inhibitors	258	252
Allopurinol	50	54
Digoxin	98	80
Enoxaparin	44	58
Frusemide*	204	233
Gentamicin*	77	38
Lithium	1	1
Metformin	64	60
Vancomycin*	37	17

*p<0.05

Improvements occurred in targeted key drugs commenced during the hospital admission, as well as appropriate therapeutic drug monitoring for gentamicin and vancomycin (see Figure 2).

*Figure 2 - (*p<0.05)*



During the pre-intervention period 38% of renally cleared drugs were held in patients experiencing acute renal failure, improving to 62% after GFR+ (p=0.01).

Frusemide was held in 18.6% of patients at some time during an admission for the pre-intervention phase compared to 30.9% of patients after GFR+ (p=0.003). There was no impact on drug dosing in cases were the patient had previously been commenced outside the hospital on too high a dose (15% vs. 20%, p=0.49).

*p<0.05 for difference between groups

In the pre-intervention period where either an ACE I, allpurinol, digoxin or metformin were initiated during the course of the admission, the starting dose was too high on 11% of occasions, compared to 6% of occasions during the post-intervention phase (p=0.34).

Discussion

The implementation of GFR+ using an academic detailing approach significantly improved a number of aspects of the management of renally cleared drugs. Prescribing of key renally cleared drugs were successfully targeted. Two drugs of particular concern in our patient population were enoxaparin and gentamicin. These two drugs are used for potentially life-threatening conditions, have a low therapeutic index, require adjustment for impaired renal function, and commonly cause serious adverse drug events in the elderly. The dosing accuracy of both these drugs improved significantly. An unexpected benefit for gentamicin management was the improvement in therapeutic drug monitoring, driven by the presence of the monitoring recommendation given with the dose. Vancomycin prescribing also improved markedly (47% to 77%), as was the use of vancomycin therapeutic drug monitoring, but

the smaller patient numbers recruited failed to reach statistical significance (p=0.07 and p=0.17 respectively).

The combination of GFR+ and academic detailing resulted in a better understanding by prescribers of those drugs needing to be held when renal function decreased. This was reflected in an improvement from 38% to 62% for renally cleared drugs held during episodes of acute renal failure. There number of instances where patients on frusemide had this drug held or ceased at some point during an admission increased after the introduction of GFR+. A key message in the academic detailing process focused on frusemide use, and we feel this change reflected a better understanding by clinicians of the potential for frusemide to cause or exacerbate declining renal function.

GFR+ allowed use of sophisticated and better suited dosing algorithms that would not be possible outside this setting. This is expected to lead to decreased rates of adverse drug events for these drugs, especially in elderly patients.

There was a high impact on prescribing, despite GFR+ not being a part of the prescribers normal workflow. GFR+ was readily sustainable across the hospital. Formal user feedback was extremely positive.

Conclusion

GFR+ significantly improves prescribing and understanding of renally cleared drugs, in the hospital setting, which should translate into a decreased rate of adverse drug events.

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