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An audit of raised potassium results from GP surgeries in June and December 2017

Background

Potassium is found inside blood cells at concentrations approximately 40-fold higher than outside cells, in the serum. The body works hard to keep potassium inside cells with a cell-membrane pump. The pump works optimally at 37^{o}C; at lower temperatures it is less efficient. Outside the body (e.g. following a blood test), the pump gradually runs out of energy to work. There are therefore two main factors which can affect the concentration of potassium in a serum sample following a blood test: time since blood was drawn and ambient temperature at which the blood sample is maintained prior to analysis.

Following a spell of particularly cold weather in December 2017, it was noted that the laboratories at York and Scarborough Hospitals were producing more results than usual with elevated potassium results in samples from GP practices.

Elevated potassium in the blood (hyperkalaemia) can be potentially life threatening. The lab will telephone all significantly elevated potassium results to the requestor or out of hours GP service, because of the potential significance of this finding. Patients may be asked to have an urgent repeat blood sample or even attend A&E because of the result.

This audit was undertaken to assess the rate of hyperkalaemia in samples received in December 2017 and to compare this with the rate of hyperkalaemia of samples received in June 2017. Further analysis of the data was undertaken to examine the effect of delayed receipt of samples, and the impact of centrifugation of samples at the GP practice.

Methods

The laboratory database, Telepath, was interrogated for all U&E results (sodium, potassium, urea, creatinine and eGFR) from GP locations during the months of June and December 2017. Locations which sent fewer than 20 samples during the month were excluded from further analysis.

The upper reference limit for serum potassium is 5.3mmol/L. An arbitrary limit of 5.5mmol/L was used to define hyperkalaemia in this audit.

Results

52 surgeries sent more than 20 U&E requests in June and December 2017.

a. Rate of Hyperkalaemia

Total numbers of samples received, and numbers of samples with hyperkalaemia are shown in table 1.

	June 2017 (22 days)	**Dec 2017** (19 days)
Total UE (Mean per day)	25,444 (1157)	19,894 (1047)
Total K ≥5.5mmol/L (Mean per day)	282 (12.8)	457 (24.0)
% of results with K ≥5.5mmol/L	1.1%	2.3%

Table 1

This data shows the rate of hyperkalaemia was over twice as frequent in December than in June.

b. Impact of Hyperkalaemia (repeated blood tests)

In December, 18 GP practices had higher than the average (2.3%) number of hyperkalaemic samples from their total samples reported. A further six practices had over ten hyperkalaemic results in December although, due to high total volume of work, this accounted for <2.3% results.

In June, only one surgery had more than 2.3% hyperkalaemic samples.

85 patients (25%) had repeat samples taken within 5 days. Mean potassium level in these patients was 5.9mmol/L. The mean difference in potassium level on the repeat samples was a fall of 0.8mmol/L (median = -0.8, range -1.8 – +0.3). A total of 176 patients (51%) had repeat samples taken within 14 days.

c. Effect of time to collection

The time taken from collection (TC) to receipt of sample (referred to as 'time to processing') was examined for all samples with hyperkalaemia (K>5.5mmol/L). Samples received already centrifuged, or over one day old, were excluded from the data. Time of collection was provided for 232 out of 282 samples in June and 409 out of 457 samples in December. As a comparator, 232 and 409 requests were examined from the total requests in June and December respectively. Samples selected were representative of surgeries in the same proportion as those with hyperkalaemia, and the samples were selected randomly (listed by patient NHS number; the first n samples were examined). This data is shown in table 2.

	June 2017 n = 232	**December 2017** n = 409
K >5.5: Mean time to processing	4h25m	5h18m
All requests: Mean time to processing	4h 53m	4h 56m

Table 2

In June, the average time to processing was actually less for samples with hyperkalamia than for all samples. This suggests that delay between collection and receipt was not a significant causative factor for hyperkalaemia in June.

In December, the mean time to processing for all requests was approximately the same as in June. However, the average time to processing for samples with hyperkalaemia was 22 minutes longer in December. It is unlikely that this relatively modest increase in delay time was a major causative factor in the increased rate of hyperkalaemia in December although, together with the colder temperatures experienced during this month, it may have played some role.

Time to processing was further examined for 15 surgeries with more than 10 hyperkalaemic samples during December.

The two surgeries with the longest mean time to processing for hyperkalaemic samples (7hours 9minutes and 7hours 17minutes) also had the longest mean time to processing for all samples (6hours 28minutes and 5hours 58minutes). In June, the combined number of hyperkalaemic samples for these two surgeries was nine, compared to 53 in December, although the mean time to processing all samples was similar to December (6hours 17minutes and 6hours 26minutes). This suggests that exposure of the samples to low temperatures during a long transport run has a much more significant effect on rates of hyperkalaemia than the delay in receiving samples for processing.

d. Effect of centrifugation at surgery

A number of surgeries have access to centrifuges, and spin samples that will not be sent to the lab on the day of collection.

1457 centrifuged samples were received in December. Of these, only 7 samples, from 6 different practices, had potassium results ≥5.5mmol/L (0.5%). Five samples were repeated. Three of the repeat results were >5.1mmol/L; all of these patients had eGFR <45mL/min/m^2, suggesting the raised potassium levels in these patients may have been secondary to renal impairment, i.e. not artefactual. Two of the repeat results were normal (<5.0mmol/L); both of these patients had eGFR >60mL/min/m^2. This suggests that the rate of artefactual hyperkalaemia in centrifuged samples in December was between 0.14 and 0.27%. As the mean rate of hyperkalaemia in all samples was 2.3%, this indicates that centrifuging samples prior to processing significantly reduces the incidence of hyperkalaemia.

Of the surgeries that sent more than 20% of samples pre-centrifuged, only one had more than 10 hyperkalaemic samples in December.

In December 2017, the overall rate of hyperkalemia for surgeries that sent more than >10% of samples pre-centrifuged was 2.6%. The overall hyperkalaemia rate for surgeries that did not centrifuge any samples was 4.6%.

It is not common practice for surgeries to centrifuge samples that will be analysed on the same day. For some samples, there is a significant delay between collection and processing, even when samples are received by the lab on the day of collection, (see section c.). Only one surgery served by our labs appears to routinely centrifuge samples which will be analysed on the day of collection. 42% of samples were received pre-centrifuged from this surgery in December and the hyperkalaemia rate was 1.8%. This surgery is located geographically close to the two surgeries with high hyperkalaemia rates and long delays between collection and processing discussed in section c. The difference in rates of hyperkalaemia between this practice (1.8%) and the other two nearby (8.3% and 5.7% respectively) can almost certainly be attributed to differing rates of centrifugation, as the samples are being transported in the van for a similar length of time under the same conditions.

Conclusions

The rate of hyperkalaemia was significantly higher in December 2017 than in June 2017. The most likely explanation for this was the colder weather in December.

The impact of hyperkalaemia on patients, GP practices, phlebotomy services, and the biochemistry laboratory is significant. In this audit, over 50% of patients with serum potassium levels ≥ 5.5mmol/L were repeated within 14 days. On average, results were 0.8mmol/L lower on repeat (range +0.3 to -1.8). There is a clear recognition among GPs that raised serum potassium results are often artefactual, but the clinical consequences of not addressing a genuinely raised potassium level may be fatal. GPs therefore have to balance the likelihood of an artifactually raised potassium level with the risk of not taking the result seriously.

When all data is viewed together, there was no significant difference between June and December in the mean time to processing. However, in December, the mean time to processing for hyperkalaemic samples was slightly longer than the respective averages for all samples. It should be considered that any delay in processing on serum potassium levels would be exacerbated by colder ambient temperatures prior to centrifugation.

When the data was reviewed by individual practices, longer journey times and delays in processing were clear factors for two surgeries with high levels of hyperkalaemia. However, three other practices with high numbers of hyperkalaemic samples did not have clearly identifiable long journey times or delays to processing (data not shown). Other factors contributing to hyperkalaemia need to be considered for these surgeries.

A number of surgeries sent a proportion of samples to the lab already centrifuged. Typically these are surgeries who provide phlebotomy services in the afternoon and are required to store samples overnight. The data obtained shows a significantly lower rate of hyperkalaemia in samples received centrifuged compared to those which are not centrifuged prior to transportation. As would be expected, the practices with a greatest numbers of centrifuged samples had among the lowest rates of hyperkalaemia.

A significant limitation in this audit is that the analysis of the data is skewed by the assumption that all hyperkalaemia is artefactual and avoidable. This is clearly false, and genuine reasons for hyperkalaemia, such as renal impairment, or medications such as ACE inhibitors, were not considered. Some surgeries may have a higher proportion of such patients registered with them due to geographical reasons.

Proposals

- All surgeries with centrifuges should be encouraged to use them to centrifuge all samples prior to dispatch to laboratory.
- All surgeries without centrifuges should be encouraged to purchase a centrifuge. Initial training and support can be provided by the laboratory.
- This audit data should be shared with surgeries (targeted with specific data, if appropriate) in order to provide information about the significance of artefactual hyperkalaemia.
- An information sheet should be produced for all surgeries that currently have centrifuges, and for all surgeries acquiring centrifuges in the future, detailing how and when samples should be centrifuged.