Supplement 1

Questionnaire 1 used for Audit 1

Health care professionals’ experience of adrenal crises

Adrenal crisis is a common life-threatening complication of Addison’s disease, and hydrocortisone and fluid resuscitation must be given quickly to prevent dangerous electrolyte abnormalities and shock.

However, Addison’s disease itself is relatively rare, and not all health care professionals immediately recognise it and know how to manage it. We would be very grateful for a few minutes of your time in completing this questionnaire.

------------------------------------------------------------------------------------------------------------

1) Job title: ______________

2) Have you personally seen a case of adrenal crisis during your career?
   □ Yes   □ No

3) Have you personally managed a case of adrenal crisis during your career?
   □ Yes   □ No

   If Yes, please comment below ………..

4) Please grade your confidence that you could promptly recognise ever seen or been involved in a case where a patient in adrenal crisis

   1  2  3  4  5  6  7
   Not at all confident  Very confident

5) To the best of your knowledge, have you or a colleague ever seen or been involved in a case where a patient in adrenal crisis was inappropriately managed due to poor management by a healthcare professional?
   □ Yes   □ No

   If Yes, please comment below ………..
6) Do you use a smartphone at work?

- Yes, and I **use** clinical apps
- Yes, but I **don't use** clinical apps
- No

We are investigating using smartphone technology and QR Codes to allow professionals to immediately gain access to information regarding the prevention of adrenal crisis in at-risk patients in common clinical scenarios.

![QR Codes and proposed patient wrist bands and cards](image)

**Some examples of QR Codes and the proposed patient wrist bands and cards.**

7) Do you think that a system which provided instant access to detailed management information in adrenal crisis would be useful to yourself and other health care professionals?

- Yes
- No

8) Would you use QR coding to access clinical information in acute settings?

- Yes
- No
Supplement 2

Questionnaire 2 used for Audit 2

Health care professionals’ views on QR-Code-linked bracelets and the Addison’s Disease Information System (ADIS)

This is a questionnaire for health care professionals regarding the improvement of access to medical management information in adrenal crisis.

Addison’s disease itself is relatively rare, and not all health care professionals will immediately recognise it and know how to manage it.

We are investigating using smartphone technology and QR Codes to allow professionals to immediately gain access to information regarding the prevention of adrenal crisis in at-risk patients in common clinical scenarios.

Some examples of QR Codes and the proposed patient wrist bands and cards.

We would be very grateful for a few minutes of your time.

9) Job title: __________

10) After using the system, please rate how useful you think the system would be in acute settings

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all useful</td>
<td>Very useful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---
11) Please comment on the proposed system and web site below: .................

12) Would you use QR Coding to access clinical information in acute settings?

☐ Yes  ☐ No

Thank you very much for your time.
A QR (Quick Response) code is one type of 2D matrix bar code developed by the Denso Wave Company, a Japanese manufacturer of automotive components, for creating parts labels capable of holding more data than conventional bar codes. It can hold one hundred times the amount of data stored by a conventional one dimensional linear bar code. Figure 1 (a) illustrates the basic anatomy of a QR code conforming to ISO (International Standards Organisation) 2005 (revision 2014). The data is held in a square dot matrix surrounded by a white border called the "quiet zone". Text or icons can be printed in this area that do not interfere with the readability of the code such as the "QR code Medical Alert" in our example. The QR code reader of the smart device's camera "locks" onto the code with the help of the three large square dots at the three corners of the code square (finder pattern). The code can be read horizontally or vertically as long as the smart device (Android, iPhone) camera is held at right angles to the code. QR codes are likely to become an exciting and popular way of accessing digital information because users like their interactivity. QR codes are free to use without copyright restriction as Denso have waived their patent rights on it. Some disadvantages of QR codes are that they do not work where there is no Wi-Fi™ (wireless local area network internet connection) such as an aeroplane or deep underground railway station and a QR code reader app has to be downloaded from the web to enable the smart device camera to read the code unless one owns the latest Apple or Android smart devices which have built-in QR code scanning software.
Part 2 – Creating and printing QR codes

Figure 1 (b) illustrates how a web-based freeware program called “QR Code Generator”\(^4\) creates QR codes. The multi-functional nature of the QR code is revealed in the six choices labelled horizontally in the figure from left to right, "web site", "phone", "SMS" (short message service), "e-mail", "text" and "mp3" (a compressed digital audio format). A QR code can be configured to make a phone call, send a pre-entered SMS text message or e-mail or play an mp3 audio file. Our Addison's Disease Information System (ADIS) web app only uses the "web site" function of the QR code. It encodes the web address of the ADIS web site in the QR code so that when it is scanned, it loads and displays the ADIS in the smart device’s web browser.
Figure 1 (a) The anatomy of a QR code (type 2005). (b) The process of generating a multi-modal QR code and printing it on a card and bracelet.
Part 3 – Accessing the ADIS by scanning the QR code-linked bracelet or card

Figure 2 shows how a QR code, printed on a bracelet or card, is read by a smart device. If one has the latest iPhone 7 or an Android smartphone running the Android Operating System Version 4.4 and above, QR code scanning software is built into the phone⁵,⁶ and the Google Chrome browser of the Android phone respectively.⁶,⁷ Users of older smart devices can download free QR code scanner apps such as "QR Code Reader" for the iPhone,⁸,⁹ and "QR Droid"⁹ for the Android phone from online web vendors.

Figure 2: Scanning the QR code-linked Addison’s disease bracelet / card with smartphone.
(Table 1). The ADIS web page can also be loaded by typing the app's web address in the web browser navigation window of the smart device, laptop or desktop PC.
Figure 3 The ADIS (Addison’s Disease Information System) main menu and some of the information content of the first three menu items.

For the Healthcare Professional responsible for my care I suffer from a life-threatening condition called Addison’s Disease have to take regular Hydrocortisone tablets to stay well. If I am ill and I cannot take them by mouth, I may die unless I receive a Hydrocortisone injection. If you find me in a collapsed or unwell state or unconscious please dial 999 for an ambulance and accompany me to hospital with this information.

Minor Operation - Local Anaesthetic

examples inguinal hernia repair, laparoscopy, cataract surgery

morning of procedure - normal morning steroid dose
pre-op - 100 mg i.m./i.v. Hydrocortisone just before surgery
post-op - double dose of oral steroid for 24 hours and then return to normal dose.
Figure 4 The ADIS (Addison’s Disease Information System) main menu and some of the information content of the last three menu items.
According to 2016 UK sales figures, the Android phone is the most popular smartphone followed by the iPhone, Windows phone and Ubuntu phone. Examples of QR code reader software and download location for all the phone types are summarised in Table 1.

<table>
<thead>
<tr>
<th>Smartphone Operating System</th>
<th>Smartphone Popularity</th>
<th>Location of free QR code Reader App</th>
<th>Example QR Reader App</th>
</tr>
</thead>
<tbody>
<tr>
<td>Android</td>
<td>81.7%</td>
<td>Google Play Store</td>
<td>“QRdroid”</td>
</tr>
<tr>
<td>Apple iPhone (iOS)</td>
<td>17.9%</td>
<td>Apple App Store</td>
<td>“QR Reader for iPhone”</td>
</tr>
<tr>
<td>Windows phone</td>
<td>0.3%</td>
<td>Microsoft Store</td>
<td>“QR Code Reader”</td>
</tr>
<tr>
<td>Ubuntu (Linux) Phone</td>
<td>0.1%</td>
<td>Ubuntu Apps Directory</td>
<td>“Qreator”</td>
</tr>
</tbody>
</table>

Part 4 – Addison’s Disease Information System (ADIS) Technical Design

The ADIS comprises a web app consisting of a single drop-down menu embedded in a page of HTML (HyperText Markup Language) Version 5 code incorporating a Javascript framework called Jquery Mobile. (Figures 3 and 4) Javascript is a server and client-side programming language for enhancing web pages and its functionality can be extended by linking it to freeware libraries such as Jquery Mobile which are located on web servers, known as CDNs (Content Delivery Networks), anywhere in the world. Jquery Mobile also supports responsive design – the graphic appearance of the ADIS
looks the same on any smart device (phone or tablet) as well as the PC laptop or desktop screen using the same coding so one does not have to write separate code for each device to achieve the same screen appearance.\textsuperscript{12}

![Diagram of wireless smart devices connecting to ADIS](image)

Figure 5 An illustration of how wireless smart devices connect to the ADIS (identified by the bubble text in the top right-hand corner of the figure).

Figure 5 illustrates how the ADIS works. It uses a “web” app as opposed to a “native” app. There are distinct differences between the two types which are summarised in Table 2.
Table 2 The functional differences between a “web” and “native” app.

<table>
<thead>
<tr>
<th>features</th>
<th>“web” app</th>
<th>“native” app</th>
</tr>
</thead>
<tbody>
<tr>
<td>location of app code</td>
<td>web - runs directly from web server</td>
<td>device - downloaded from web server, runs on the device</td>
</tr>
<tr>
<td>speed of app code</td>
<td>app may run slowly depending on the speed of the web connection</td>
<td>app runs quickly on the device</td>
</tr>
<tr>
<td>ease of update</td>
<td>yes – app code will always be up-to-date on the web server</td>
<td>no – app update needs downloading from the web server</td>
</tr>
<tr>
<td>needs a web connection</td>
<td>yes</td>
<td>no – unless app needs a web connection to run</td>
</tr>
<tr>
<td>flexibility</td>
<td>app can be saved on the device and run from it (not Iphone)</td>
<td>app stored on and run from the device</td>
</tr>
</tbody>
</table>

Part 5 – Information Content, Provenance and Security of the ADIS

The information content of our ADIS is mainly derived from the high quality educational material available to patients with Addison’s disease on the Addison’s Disease Self-Help Group\textsuperscript{13} and its Clinical Advisory Panel\textsuperscript{14} and has been checked and approved by J.W., our experienced NHS Consultant Endocrinologist. Some of its content is displayed in Figures 3 and 4. The web app does not contain any personal data except the NHS contact details of J.W for her patients with Addison’s disease to access for which her consent was obtained. The ADIS web app is hidden from web search engines such as
Google by the use of special codes in the HTML document.

References

7 Burns C. QR code scanner now built in to Chrome app. February 2, 2017 [https://www slashgear.com qr-code scanner now built in to chrome app 02473618/](https://www slashgear.com qr-code scanner now built in to chrome app 02473618/) (accessed June 2017)
9 UQR. The 11 Best QR Code Reader Apps for Android, iPhone, Windows Phone and Blackberry. [https://uqr.me/blog/best-qr-code-readers/](https://uqr.me/blog/best-qr-code-readers/) (accessed June 2017)