The Global Language of Business

The Management of Medical Equipment using GS1 Standards

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Disclaimer

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1. Executive Summary

Clinical engineering departments are increasingly responsible for the full asset life cycle including total cost of ownership and importantly the management of outsourced contracts for a broad range of medical equipment including, walking aids, hoists, X-ray machines and fixed equipment in theatres.

The use of GS1 standards together with bar code and Radio Frequency Identification (RFID) technology can provide the management information and process controls to manage these assets more effectively. This can lead to improved asset utilisation, better equipment maintenance, improved patient safety and reduction in time spent locating equipment.

Using bar coded asset identifiers linked to the bar coded patient wrist band enables the efficient recording of which medical equipment has been used on which patients.

The first step is to identify and label assets with a GS1 Global Individual Asset Identifier (GIAI) bar code and/or a GS1 passive RFID tag. This enables the asset to be identified and scanned so that information about processes such as maintenance, decontamination and repair can be recorded accurately and quickly.

RFID can be used to provide accurate information about where assets are located which can substantially improve utilisation. Real Time Location Systems (RTLS) for assets can be expensive however lower cost alternatives are available which can provide location information every few hours which may be sufficient for most purposes.

Experience in trusts implementing improved equipment management systems showed the following benefits mainly due to better asset location information and the operation of a medical equipment library:

- Utilisation for Patient Controlled Analgesia Management (PCAM) devices doubled
- Reduction in nurses time searching for PCAM devices was equivalent to a saving of £18,000 per year
- Capital cost saving of £92,000 on mobile electrocardiogram (ECG) monitors due to increased utilisation
- Expected 10% reduction in all types of pumps held by the trust
- Maintenance inspection rates for all devices at 99% of planned
- Preventive maintenance for ECG monitors up from 57% to 90% of planned
- Device location accuracy improved from 65% to 92%

2. About this document

2.1. Background

This document was commissioned by the Health and Social Care Information Centre in order to provide best practice guidelines on how GS1 standards can be used to improve the management of assets within the NHS. It explains the use of Automatic Identification and Data Capture (AIDC) technology to improve data accuracy, to reduce administration time and provide better management control. In addition the document shows how GS1 standards can help trusts to meet the challenge of a paperless NHS by 2018 laid down by Jeremy Hunt, the Health Secretary.

2.2. Scope

The BSI PAS 55-1 Asset Management standard (see also ISO 55000) defines asset management as the

systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purpose of achieving its organizational strategic plan.

It then categorises these activities using the Plan-Do-Check-Act (PDCA) framework.

The scope of this paper is limited to the use of GS1 standards in the "Do-Check" activities and processes and in particular in the establishment of asset information management systems and the monitoring and measuring of results against the asset management policy and strategies. The document covers all reusable medical devices with particular focus on devices managed by Clinical Engineering and Medical Physics.

2.3. Purpose

This document is designed to assist and advise trusts, and their solution partners, in developing improved medical equipment information systems using GS1 standards.

3. Recommendations

- GS1 identifiers, bar codes and RFID tags should be used to identify medical equipment, physical locations, organisational entities, staff, patients and products.
- Active or passive RFID technology should be used to improve information about equipment location, however real-time location information is not necessarily required.
- Where possible paper based systems should be replaced by automated bar code or RFID reading devices which are able to update asset databases without the need for rekeying information
- Equipment commissioning, transfers, repairs and maintenance should be tracked using bar code or RFID readers in order to build up the accurate information required to improve asset management policies and processes.
- New bar code scanners procured by trusts should be capable of reading 2 dimensional bar codes such as the GS1 DataMatrix as agreed by the GS1 Healthcare User Group http://www.gs1.org/docs/healthcare/GS1_HUG_ps_Camera_Based_Scanners.pdf

4. Benefits

The use of GS1 standards with bar codes and RFID technologies can provide the following benefits

- Reduction in time spent maintaining asset databases and registers
- Reduction in use of paper forms and improvement in data accuracy since information is entered directly by scanning bar codes
- Reduction in time, especially nurses' time, spent looking for equipment
- Improved utilisation of equipment leading to a reduction in purchases of new equipment and consequently to a reduction in the total number of assets in the trust
- More comprehensive and accurate information about the use of medical equipment leading to better procurement and management policies and decisions
- Improved ability to allocate equipment maintenance and repair costs to departments
- Improved patient safety by improved equipment maintenance
- Improved patient safety by recording which equipment has been used on individual patients through the use of GS1 compliant barcoded patient wristbands
- Reduction in rental charges and lease penalties from being unable to find assets which need to be returned at the end of their lease agreement

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5. Definition of Medical Equipment

"Medical equipment" is an informal term used in this document to denote reusable medical devices involved in the treatment of patients and managed by clinical engineering. This is a subset of medical devices as defined in the MHRA Device Bulletin DB2006(05) November 2006. (See http://www.mhra.gov.uk/Publications/Safetyguidance/DeviceBulletins/CON2025142) Clearly the precise equipment managed by clinical engineering will vary between hospitals. Medical equipment typically includes

- Infusion pumps
- Pain Pumps
- Fixed equipment such as gas flow meters
- Specialist theatre equipment such as lighting
- Specialist beds and mattresses
- Hoists
- Walking aids including wheel chairs
- Finger probes
- other reusable medical devices

The following are likely to be managed outside of clinical engineering

- specialised machinery such as MRI scanners
- Single use devices such as implants.
- Surgical instruments
- Pharmaceuticals and reagents

6. Medical Equipment Management

Traditionally clinical engineering or medical physics departments focussed on the physical acquisition, repair and maintenance of mainly electrical medical equipment. This is rapidly changing with clinical engineering becoming responsible for the full asset life cycle including total cost of ownership and importantly the management of outsourced contracts (see Figure 1 - Asset Life Cycle) for a broad range of medical equipment including, walking aids, hoists, X-ray machines and fixed equipment in theatres.

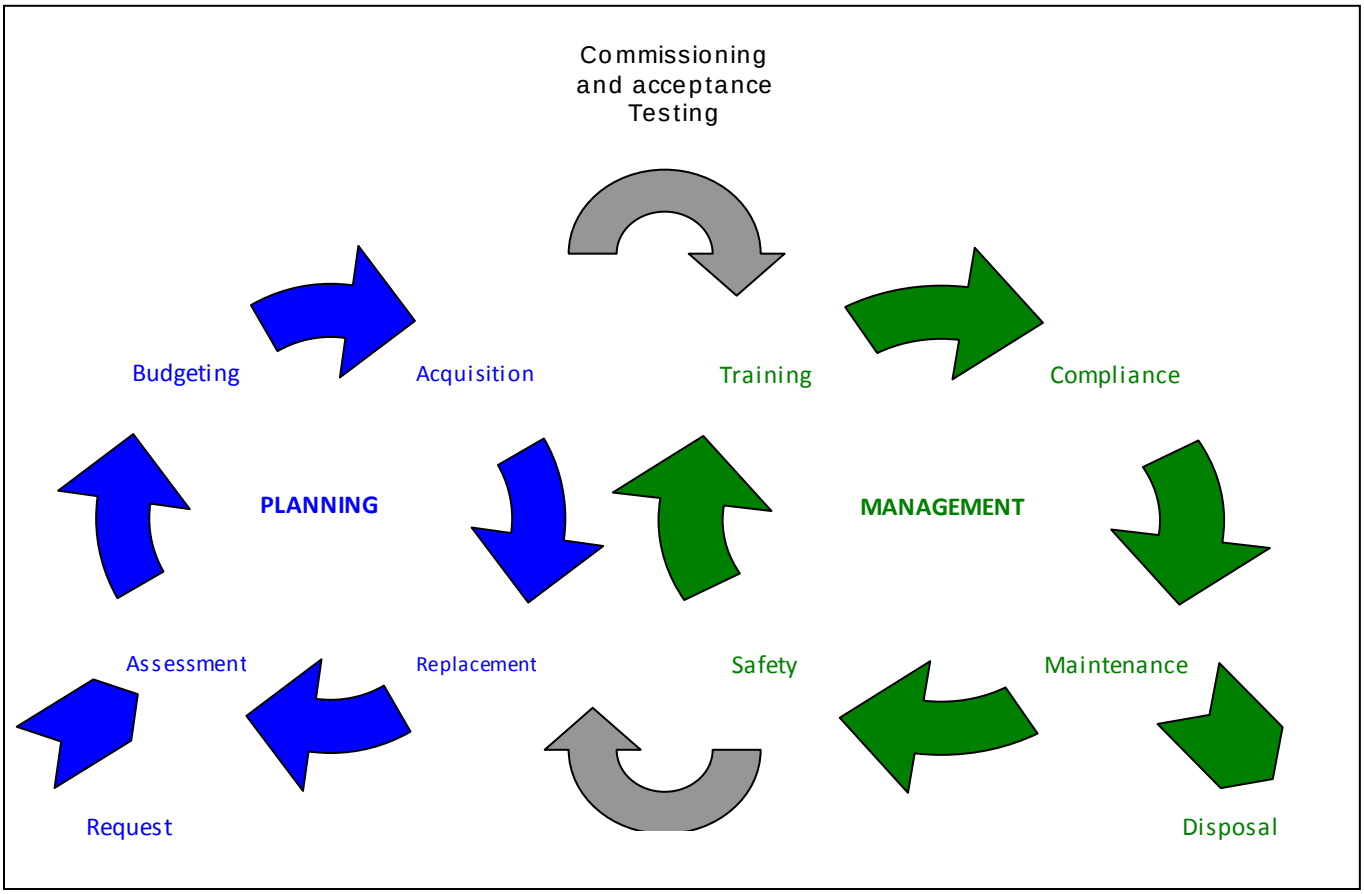

Figure 1 - Asset Life Cycle (provided by Hardus Bosman, Royal Marsden Trust)

With the increase in scope comes a requirement for improved management information about the location, status and utilisation of assets. This information is difficult to collect and maintain in hospital environments and typically involves many paper records which are rekeyed into asset databases.

Current issues facing medical equipment managers include

- Locating equipment for planned maintenance
- Locating leased equipment to be returned at the end of their lease agreement.
- Locating equipment in limited supply or with high demand such as bariatric hoists
- Too many items listed as lost or status unconfirmed in the asset database
- Lack of equipment utilisation data and other management information
- Management of outsourced contracts
- Paper documents and rekeying in an attempt to keep asset databases up to date.
- Inconsistent approaches to asset management in different departments
- Lack of information making it difficult to make a business case for change.

7. Stakeholder Requirements

Medical equipment involves many departments beyond those involved in patient care. For example

- medical equipment may be moved about the hospital by porters managed by estates

- medical equipment may need to be registered and tracked in a finance asset register for audit purposes
- procurement will be involved in purchase processes and decisions
- ambulances may arrive or leave with equipment
- community services may take over responsibility for equipment from the hospital.

Table 1 shows what various stake holders require of any asset management system.

Table 1 Requirements

Clinical	Need access to the correct equipment, in cleaned and serviceable condition in the correct location when required. Need to be warned when equipment is due for planned maintenance or needs to be returned at the end of a lease agreement, or when warranties are about to expire
Finance	Need accurate, auditable information about capitalised assets in an asset register showing equipment location and ownership Need the ability to allocate asset costs to relevant budget holders
Technical Maintenance	Need accurate information about planned maintenance requirements for each asset including its current location
Management	Need information to confirm that assets are managed efficiently and according to the trust's asset management plans and policies. Need systems and processes to minimise the opportunities for equipment to be stolen, damaged or used without authorisation, and to identify who is responsible. Need to understand the total cost of ownership of equipment and any impact on clinical outcomes Need knowledge of all out sourced contracts and the supplier performance against those contracts.

8. GS1 Standards

8.1. Identifiers

The Department of Health recommends using GS1 standards in "Coding for Success" in NHS England as documented in "Coding for Success" published in February 2007. The NHS mandates GS1 standards in "Better Procurement, better Care" published in August 2013 and the "NHS eProcurement Strategy" due to be published in April 2014. NHS England and the Health and Social Care Information Centre (HSCIC) also promote the use of GS1 standards in the NHS.

ISB 1077 and ISB 0108 define the use of GS1 standards and how they should be used by the NHS and its suppliers for identifying products, patients, locations and assets and for the use of bar codes. The benefits of using GS1 standards include

- GS1 identifiers are globally unique, they do not need to be changed when trusts separate or merge and they can be used by suppliers and contractors without requiring the maintenance of complex cross-reference tables.
- Bar code and RFID readers can recognise and select GS1 bar codes and RFID tags even when other bar codes or tags are present using features that are ISO standards
- Data in GS1 bar codes and RFID tags has a well-defined structure that can be understood by any relevant application

All GS1 identifiers (also known as keys) start with a sequence of numeric digits called a GS1 Company Prefix, which GS1 allocates to individual companies. Subsequent digits or characters are appended to the prefix to create unique identifiers for specific items.

GS1 works closely with ISO to ensure that GS1 standards are recognised by ISO. GS1 has recently been given special status (JTC 1 PAS Submitter) which speeds the process for GS1 standards to become ISO standards.

Fundamentally GS1 standards provide an infrastructure of identifiers, bar codes and RFID tags that can be used by any application in any organisation. GS1 standards enable integration of systems within the trust and allow information from external providers' systems to be incorporated easily into the trust's information management and control systems.

These benefits are particularly applicable to medical equipment management where the outsourcing of asset ownership, repair and maintenance is increasingly common.

GS1 recommends that the identifiers are not used to encode information since such schemes are rarely flexible enough for the long term. It is normally better to use the identifier purely as a key to look up information in a database.

8.2. Bar Codes and RFID Tags

GS1 standards specify the minimum size of bar codes to ensure that they can be read reliably by a wide range of equipment in different environments. Actual readability of bar codes will depend on the quality of the printer used to print them and of the scanner used to read them.

GS1 linear or one dimensional (1D) bar codes (GS1-128) may be too large to fit on some items. GS1 two dimensional (2D) bar codes (GS1 DataMatrix) can be much smaller and can be read more reliably, they are also likely to become common on pharmaceutical and other products purchased by the trust. For these reasons two dimensional bar codes are the preferred option. However two dimensional codes may not be readable by some legacy bar code readers in the trust. (See section 16.2 GS1 Bar Codes)

When a GS1 key is encoded in a GS1 barcode it is prefixed by an Application Identifier (AI) number which identifies the type of GS1 key so that it can be interpreted and processed correctly.

Asset bar code labels suitable for hospital use are likely to cost around 5p with a further cost of around 20p if a passive RFID tag is included. Actual costs will vary with the label type and the volume purchased. Given the potential benefits that RFID tags can provide they should be considered as a replacement, or more likely, as complement to the use of bar codes.

8.3. Information Exchange

GS1 standards also enable the exchange information between companies in the following ways

Electronic Messages

GS1 has defined standard electronic commerce (eCom) messages for a wide variety of business transactions including orders, invoices, and delivery notes.

Data Pools

Manufacturers can input data into GS1 standard data pools for automatic onward delivery to their customers. This ensures that customer receive the correct data in a standard form from all manufacturers while manufacturers only have to enter the data once for all their customers. The GS1 standard data pools are fully compliant with the US Global Unique Device identification Database (GUDID) but can also provide significant additional information and functionality.

Visibility Data

GS1 bar codes and Radio Frequency IDentification (RFID) tags enable automatic tracking of products at key points in the supply chain. This information is stored in GS1 standardised event repositories which can then be accessed by authorised users to provide full visibility of products as they pass along the supply chain.

9. Best Practice Identifiers for Asset Management

This section reviews where GS1 standards apply to the information which BSI PAS 55 2 Guidelines (See http://pas55.net/ and now incorporated into ISO 55000) state should be considered for inclusion in an asset information management system.

9.1. Asset Identification

Each asset should be identified by GS1 Global Individual Asset Identifier (GIAI). GIAIs are globally unique and can therefore continue to be used when trusts separate or merge. In addition rented assets, such as specialist mattresses, can be given a GIAI by an external contractor knowing that this identifier will not clash with any other hospital assets or any other supplier assets.

9.2. Asset Labelling

A label containing the GIAI in both human readable format and in a GS1 bar code and/or GS1 RFID tag should be attached to each asset. This will ensure that applications, including those of external contractors can scan and record the bar codes and RFID tag data s directly into their systems.

9.3. Physical Location Identification

Each relevant location should be identified by a GS1 Global Location Number (GLN). Relevant locations will include those within the trust itself and also those of external organisations providing services such as repair and maintenance. This will enable suppliers to use the trust delivery location identifiers without having to maintain complex internal cross reference tables. See also the paper "Recommendations on the use of GLNs in NHS Trusts" in section 18 References

The GS1 UK web site provides a Numberbank function where GLNs and their description can be created. This ensures that GLNs are formed correctly including the necessary check digit. A bulk upload and download facility is available making it straightforward to integrate GLNs into the trust's internal systems. For more information email healthcare@gs1uk.org or phone 0808 1728390.

It is important to ensure each relevant location is identified by one and only one GLN. Estates will probably already have a database of hospital locations to which a field for the GLN can be added. As the layout of the hospital changes estates can add new GLNs as necessary.

It is suggested that estates takes the lead in managing and maintaining an internal database of GS1 GLN physical location identifiers and the installation of the associated GLN bar code labels. A similar process to that for labelling assets can be used for labelling physical locations.

9.4. Location Labelling

A label containing the GLN in both human readable format and in a GS1 bar code and/or GS1 RFID tag should be attached to each location. This will enable applications, including those of external contractors, to use the bar codes and RFID tag data directly within their systems. For example delivery services or other outsourced services will be able to use the location bar code to confirm the correct delivery location and then to record where the delivery was actually made or where the pick-up occurred.

9.5. Organisational Identifiers

Budget holders and departments should also be identified by a GS1 GLN. In addition to their use in asset management the GLN can be used to provide a unique reference to identify bill to and ship to information within supplier orders and invoices. Indeed the use of GLNs is likely to be mandated as part of the NHS procurement strategy.

The GS1 GLN Numberbank as described in Section 9.3 Physical Location Identification can be used to create GLNs for budget holders and departments.

GS1 UK suggests that finance or ICT should take the lead in creating and maintaining a database of GLNs to identify departments and budget holders. The GLNs can be created sequentially and

entered into a field in the relevant finance database. The existing budget codes can continue to be used internally but the GLN will be used when communicating outside of the trust.

GLNs are expected to be an important part of the NHS eProcurement strategy due to be published in Q2 2014.

9.6. Asset Allocation

The department or other organisation who is the budget holder or who has been allocated responsibility for an asset should be identified by a GS1 Global Location Number (GLN). This will enable external service providers to use this identifier in their internal systems and in their electronic invoices and other communications without having to maintain complex internal cross reference tables.

It is important to ensure each department is identified by one and only one GLN. Finance will probably already have a database of departments and budget holders to which a field for the GLN can be added. As the organisation structure of the hospital changes finance can add new GLNs as necessary. (See GS1 UK paper “Recommendations on the use of GLNs in trusts”)

9.7. External Service Provider Identification

External supplier of products and services should identify themselves using their own unique GLN. This will enable the trust to use this identifier in their internal systems and in their electronic orders without having to maintain complex internal cross reference tables.

The forthcoming NHS eProcurement strategy is expected to promote the use of GLNs to identify suppliers to the NHS.

9.8. Patients

It may on occasions be necessary to record on which patient a device has been used. This could be for potential infection control or to take action if equipment is found to be faulty. The NHS standard for patient identification, ISB 1077, is to use a wrist band with a GS1 DataMatrix bar code compliant bar code encoding the NHS number as a GS1 Global Service Relationship Number (GSRN); increasingly all patients will have such wrist bands.

9.9. Staff and Service Providers

It may be necessary to record which staff operated or serviced equipment, or to record which staff have taken items from a medical equipment library. Healthcare professionals and other trust staff should be identified by a GSRN (See section 16.1 GS1 Keys for Asset Management). External service provider staff should be identified by a GSRN provided either by the trust or the service provider itself, whichever is most convenient.

The GSRN can be encoded in a GS1 Bar Code or RFID tag incorporated in an identity badge.

Using the GSRN enables internal and external staff that move between hospitals and trusts to keep the same identity and avoids proliferation of access or identify cards.

10. Best Practice Processes

The following sections assume that an accurate automated location system for assets is not available. This is likely to be the position for many trusts. Section 11 Automated Location System considers best practice where automated location systems are available

10.1. Commissioning

Newly acquired assets should be given a GIAI. The asset database may generate the GIAI and print the asset label although if RFID tags are to be used then an RFID writer would be required.

Alternatively a pre-printed GIAI label, incorporating an RFID tag if required, can be attached to the asset and scanned to enter the correct GIAI into the database.

Often the supplier's product code, serial number, batch number and expiry date will all have to be written to fields in the asset database. Increasingly this information will be available as a GS1 product bar code on the product itself which can be scanned directly into the asset database without the need for rekeying.

The location of the asset following commissioning can be updated directly into the register by scanning the GIAI and the GLN bar code of its current location at the commissioning site. Alternatively the GLN may be known by the commissioning application so eliminating the need to scan the GLN.

Additional information such as the asset owner and dates for planned maintenance will need to be entered into the asset database.

If the asset is capitalised it may be necessary to update a separate financial asset registry. This should ideally be handled by an automated feed without the need for any rekeying.

10.2. Delivery to the User

Once the asset has been delivered to the user the deliverer will use a hand held scanner to scan the GIAI of the asset and the GLN of the location to which it has been delivered. This will either update the asset register in real time or else will update it once the hand held is returned to its docking station.

10.3. Allocating equipment to in-patients

Bar codes and scanning linked to asset and other trust databases can be used to

- Check that the correct equipment is used in a patient's treatment- ; for example checking that the infusion pump has the correct profile for this ward, or that the equipment is not overdue for a service
- Check that the equipment has been properly cleaned and serviced between patients
- Record which assets have been used in the treatment of which patients – in order to identify affected patients where equipment is subsequently found to have been faulty or contaminated
- Record asset utilisation - to ensure even use and correct maintenance and to provide management information for purchase decisions

To achieve this hand held scanners could be used to

- Scan the asset bar code, healthcare professional ID and the patient's GS1-compliant barcoded patient wristband, when allocating equipment to the patient and again when removing the equipment, and update the asset database.
- Scan the asset bar code and operative ID when carrying out cleaning/servicing and update the asset database.

10.4. Allocating equipment to out-patients

The process for allocating equipment for use in the patient's home or other location outside of the hospital is similar to allocating equipment to in-patients. The main difference is that the record would show that the asset is going with the patient to a location outside the hospital.

10.5. In House Planned Maintenance

When an asset becomes due for planned maintenance, the asset database should generate a notification including the asset's current location. This information can be downloaded into an application on a handheld device carried by the maintenance person who can scan the asset to confirm that maintenance has taken place and to confirm the assets physical location. Again this information should then be uploaded into the asset database.

Where *in situ* maintenance is not possible the hand-held device should merely scan and record the location from which the asset was collected and its new location in the repair facility. As the asset moves through the maintenance process its location and status can be recorded using bar code scans as required. Finally when the asset is delivered back to the user the asset Id and location can be scanned to update the asset database.

10.6. In House Repair

When an asset is in need of repair its record should be accessed in the asset database and a work item generated. The work item, identifying the asset, its location and other relevant information can then be downloaded into the hand-held device of the person who will undertake the repair. If the repair can be made *in situ* then on completion of the repair the GIAI and the GLN bar codes should be scanned and the asset database updated

If the asset cannot be repaired *in situ* then the process is similar to that for planned maintenance.

10.7. Out-sourced Maintenance and Repair

Any rented, leased or loaned assets should be entered into the asset database in a similar way as for assets owned by the trust with the exception that if the asset is already labelled with a GS1 asset identifier then there should be no need to relabel. In addition external suppliers should provide information in electronic form about the repairs and maintenance they have carried out on assets that are rented so that this information can be uploaded into the asset database.

10.8. Equipment Library

Where an equipment library is used the process can be very similar to that for planned maintenance. However if a library is left unattended, for example overnight, then the clinical staff might not always scan equipment bar codes when booking equipment in and out of the library

Booking in and out of the library can be further automated by using RFID tags on library equipment. RFID readers can then record any items removed or returned to the store and any staff who entered or left the library. This should be sufficient to follow up on any items that have been removed without providing the required information.

It should be noted that in the absence of an equipment library it is difficult and expensive to get the accurate equipment utilisation figures that are required for more effective equipment management. Even where a library is in use the utilisation information is only related to the time that an asset has been booked out. This might not correlate closely to the time the asset was actually being used.

10.9. Disposal

10.9.1. End of contract

The asset database should highlight any assets that are leased or rented and whose contract is finishing. These assets can then be collected, prepared for return as required by the contract, their asset id and location scanned and the asset database updated.

10.9.2. End of life

The bar code of an asset that has been agreed for end of life disposal can be scanned and the relevant record updated to show that they are available for pick up.

When the asset finally leaves the trust it can again be scanned and the asset database updated confirming that the trust is no longer responsible for the asset. In addition if the asset had been capitalised it may be necessary to update a separate financial asset registry. This should ideally be handled by an automated feed without the need for any rekeying.

10.10. Financial audit

Trusts are subject to the same financial regulations as other organisation and are required to carry out regular physical audits of their assets.

If this process is carried out on a more frequent basis then it can highlight any assets that have gone missing and timely action can be taken.

11. Automated Location System

Where an automated location system is available there may be no need to scan bar codes to update the asset database with the asset's location. However there may still be a requirement to scan an asset's bar code to update its current status, for example that it is currently awaiting disposal, or that it has been allocated to a specific patient or that it was serviced at a specific time. In effect much of the bar code scanning documented in section 10 Best Practice Processes will still provide useful information.

If the trust has an accurate real time location systems it may be possible to infer that an asset, such as an infusion pump, that is not close to a bed is probably not in use. Equally mobility equipment, such as a wheel chair, that has not moved for a period of time is also probably not in use. This could make it possible to get more accurate utilisation information on assets.

12. Creating GS1 Identifiers and Labels.

Clearly it is essential that the trust should ensure that there is no duplication in the creation of GS1 identifiers. This will require the trust to put in place a governance process for the creation of GS1 identifiers. (See GS1 UK paper "GS1 Company Prefix Governance")

The example bar code sizes shown below are the minimum size specified by GS1 standards and this should ensure that they can be read in the widest possible situations. Actual readability will depend on the quality of the printer, the capability of the scanner and the light conditions. Modern scanners in well lighted environments may successfully read smaller bar codes than those specified in the GS1 standards.

GS1 DataMatrix bar codes can be very small depending on the level of error correction required and the size of data to be encoded. This makes them suitable for marking small assets, although the human readable information on the asset label may limit how small the label can be. Note however that only camera based scanners can scan GS1 DataMatrix bar codes.

Care should be taken to ensure that any asset labels meet the requirements of infection control.

12.1. Asset Identifiers and labels

GIAIs can be up to 30 characters long, however GS1 recommends that a standard length for the GIAIs to be used in a trust is agreed, a 5 or 6 character code in addition to the GS1 Company Prefix is suggested. This will ensure that any linear bar codes will be of a consistent size for all assets. The example bar code below is for a GIAI made up of an 8 digit company prefix of 50123450 and a 5 digit asset number of 00008. The 8004 is the application identifier (AI) showing that the following digits represent a GIAI. (Note the brackets are for human readability only and are not encoded in the bar code)

The first step is to agree the layout of the labels. See below for an example layout which provides a clear human readable number which will normally be sufficient for manual processes.

00008

Label suppliers can provide pre-printed labels with sequential GIAI bar codes, optionally with an integrated GS1 passive UHF RFID tag. These tags can be attached to new assets as part of the commissioning process. The bar code label can then be scanned to create the record in the asset database. Other information about the asset can then be entered.

If assets carry a non GS1 compliant label they can be relabelled as follows. Attach the GS1 compliant GIAI bar code label to the asset The GIAI should then be scanned and the old asset ID entered (via another scan if this is bar coded). The association between the new GIAI and the old asset ID can then be uploaded into the asset database. Old bar codes should be defaced so that they cannot be read or the old label removed completely

GS1 UK suggests that if necessary existing assets should be relabelled as they are repaired or serviced. The remaining assets can be relabelled as part of an asset audit required by the finance department.

If a suitable bar code label printer is available then labels can also be printed on demand.

12.2. Physical Location Identifiers and Labels

GS1 GLNs consist of 13 numeric digits including a check digit. Assuming that the trust has been allocated an 8 digit GS1 company prefix this allows for 10,000 unique locations to be identified, GS1 UK can allocate additional company prefixes if more location identifiers are required.

Alternatively GS1 standards also support a 20 character alpha numeric GLN extension component which substantially increases the number of locations that can be identified with a single GS1 prefix. However the use of the GLN extension is restricted to internal use and GS1 UK recommends that it is not used unless there are special reasons for doing so.

It is recommended to use a GLN for each physical location unless there are special reasons for using an SGLN.

The GLN bar code label can include a human readable description of the location if required as shown in the example below. However in many cases the location will already have a name label.

Ward 10

Ward 10

The GS1 UK web site provides a Numberbank function where GLNs can be created and linked to a description. This ensures that GLNs are formed correctly including the necessary check digit. A bulk up and download facility is available making it easy to integrate GLNs into the trust's internal systems. For more information email healthcare@gs1uk.org or phone 0808 1728390.

The GS1 GLN in Healthcare Implementation Guide (http://www.gs1.org/docs/gsmp/healthcare/GLN_Healthcare_Imp_Guide.pdf) and the GLN Allocation Rules (http://www.gs1.org/1/glnrules/) provides more information about the use of GLNs.

13. Asset database and GS1 Identifiers

It should be recognised that some manufacturers or service providers to the trust may use a GTIN (application identifier 01) or a GRAI (application identifier 8003) with serial number or a GIAI (application identifier 8004) to identify their assets. For this reason it is recommended that the application identifier should be included in the asset identifier field in the asset database. For example an asset with GIAI of 50123450 should be held in the database as 800450123450.

The asset database should be able to hold the largest asset identifier that the GS1 standards allow which is 36 alpha numeric characters as shown below.

GIAI is a maximum of 30 characters; the GIAI AI 8004 is 4 characters making a total of 34

GRAI plus serial number has a maximum of 30 characters, the GRAI AI 8003 is 4 characters making a total of 34

GTIN plus serial number has a maximum length of 14+20, the GTIN AI 01 is 2 characters making a total of 36

14. KPIs and Reporting

Clinical engineering departments will track KPIs linked to the asset management objectives set by the trust. The following KPIs are suggested for tracking performance of asset management from commissioning through to disposal and which should be impacted by the introduction of GS1 standards and automatic identification and data capture (AIDC) as outlined in this document.

- Percentage of planned preventive maintenance carried out on time
- Percentage of equipment not found first time for planned maintenance
- Average repair turn round time
- Percentage of equipment listed with status of lost/not known or similar
- Percentage of time that an asset is in use (however this will require recording the association of equipment to patients which may not be possible initially)

Useful reports include

- Which assets are due for maintenance in the next day/week/month.
- Which assets need to be returned in the next day/week/month in order to avoid lease penalties or other additional contract costs.
- Which assets haven't been detected by the system for X number of days/weeks/months.

- The length of time an asset has been in use since purchase/maintenance/service, etc.
- Mean time between repairs for different asset models

(all time periods above would be user configurable)

15. Getting Started

Bar code labelling of assets and the purchase of a small number of hand held bar code readers can probably be authorised by clinical engineering management. This would provide some benefits in managing maintenance and repair processes carried out by clinical engineering.

- Find out more about GS1 standards and who else is implementing them within your trust by contacting GS1 on 0808 1728390 or healthcare@gs1uk.org
- Visit other trusts who have implemented improved systems
- Assess current performance
  - % of planned maintenance carried out on time
  - % and value of equipment listed as lost or status unconfirmed
- Build a business case based on the benefits in section 4 Benefits
- Agree a phased implementation plan concentrating on scanning by clinical engineering to prove technology and systems
- Assess and update or replace existing asset database to ensure support for GS1 identifiers
- Identify a suitable solution partner with experience of GS1 standards to source printers, labels and scanners
- Agree GLN labelling of physical locations with estates
- Agree with finance to create/maintain a GLN database for entities

16. Appendix 1 – GS1 Standards

GS1 keys identify entities in a wide variety of industry sectors including healthcare. These keys all start with a sequence of numeric digits, called the GS1 Company Prefix (GCP), which GS1 allocates to individual companies. Subsequent digits or characters are appended to the prefix to create unique identifiers for specific items.

When a key is encoded in a GS1 bar code it is prefixed by an Application Identifier (AI) number which identifies the key. The information in a GS1 bar code is also printed in human readable form adjacent to the bar code. The Application Identifier is enclosed in parentheses in the human readable form but the brackets are not encoded in the bar code itself.

More detailed information on all GS1 keys and bar codes is available at http://www.gs1.org/barcodes/technical/id_keys.

The complete GS1 identification and bar code standards are documented in the GS1 General Specifications available at http://www.gs1.org/genspecs.

16.1. GS1 Keys for Asset Management

The most common keys are summarised below.

16.1.1. GIAI – Global Individual Asset Identifier

The GIAI can be used to identify any asset including such things as, computers, vehicles, surgical instruments, pumps and specimens.

16.1.2. GLN – Global Location Number

The GLN can be used to identify physical locations and organisation entities where is a need to retrieve pre-defined information to improve the efficiency of communication with the supply-chain. Global Location Numbers are a prerequisite for GS1 eCom message.

GLNs can have an additional extension component to identify sub locations.

16.1.3. GSRN – Global Service Relation Number

The Global Service Relation Number (GSRN) can be used to identify the provider or recipient of a service. In the NHS the GSRN is used on the patient wrist band to identify patients and may also be used to identify healthcare professionals.

16.1.4. SSCC – Serial Shipping Container Code

The SSCC can be used to identify an item of any composition established for transport and/or storage which needs to be managed through the supply chain. The SSCC is assigned for the life time of the transport item and is a mandatory element on the GS1 Logistic Label. SSCCs are used to identify the pay load on a pallet, in a roll cage or in a package.

16.1.5. GTIN – Global Trade Item Number

The GTIN is the GS1 Identification Key for any item (product or service) that may be priced, or ordered, or invoiced at any point in any supply chain. The GTIN is then used to retrieve pre-defined information about the item. The key benefit is that information about the item can be retrieved whether it is read in a GS1 bar code symbol, exchanged via a GS1 eCom message or accessed from the Global Data Synchronisation Network.

16.1.6. Global Returnable Asset Identifier - GRAI

The GRAI is used to identify returnable items such as pallet bases, roll cages, plastic containers or gas cylinders which are used in the movement of goods. The goods themselves are identified by a GTIN or an SSCC.

16.1.7. GDTI – Global Document Type Identifier

The GDTI is the Identification Key for a document type, for example a form, a certificate or a warranty. It can be combined with an optional, alpha-numeric serial number to identify specific instances of a document type.

16.2. GS1 Bar Codes

When GS1 keys and attributes are encoded into GS1 bar codes they are preceded by codes, known as Application Identifiers. For example GIAIs are preceded by AI 8004 while a GLN for a physical location is preceded by AI 414. The standard for GS1 bar codes is that the data encoded in the bar code should also be shown in human readable form. For readability AIs are enclosed in brackets in the human readable text although the brackets are not contained in the bar code itself.

The bar codes likely to be used in asset management are either GS1 128 or GS1 DataMatrix

Examples are shown below.

16.2.1. GS1 128

This bar code can be read by virtually any bar code scanning device.. The data structure in the bar code is defined to enable batch numbers, expiry dates and a wide range of other information to be included.

GS1 128 bar code is a relatively large image the size of which varies with the information it contains. The example shows a GS1 128 bar code containing a GIAI.

16.2.2. GS1 DataMatrix

The GS1 DataMatrix bar code can carry more information than the GS1 128 bar code in a much smaller space; it can also be read even when the bar code image has been damaged in some way assuming that the optional error correction capability has been used. However GS1 DataMatrix requires a camera scanner, such as those in mobile phones. GS1 DataMatrix cannot be read by the laser scanners which may already be deployed in some departments.

Again the size of a GS1 DataMatrix bar code will vary with the information it contains the level of error correction used. The example shows a GS1 DataMatrix containing a GIAI.

17. Appendix 2 – Asset Location Technology

Assets such as infusion pumps are likely to move around the hospital without their new location being recorded in the asset database. This can lead to assets being unable to be found when their planned maintenance is due. In the worst case the asset may never be found and will have to be written off without any clear idea of who should be held responsible for the loss.

There are a variety of approaches to getting more accurate location information about current location of assets with a hospital.

17.1. Mobile reader active and passive tag

It may not be possible for economic or other reasons to provide real time location of assets. In this situation an alternative approach is to tag assets with either active, semi passive or passive tags. A user with a mobile reader can then move around from location to location. At each location the mobile reader records the assets whose tags it can read and reports this back. Reporting back can be done through a suitable Wi-Fi connection or via a docking station linked into the hospital LAN.

This is a low cost approach, especially if passive or semi passive tags are used, but can provide very useful location information.

Room level accuracy will not be 100% reliable since radio waves may pass through walls.

Active Tag

Active tags cost around £30 and can be read from a distance of many meters. They typically are encased in a protective plastic casing in a wide variety of formats. The tags can attached to assets with glue, a lanyard or screws. Some examples are shown below.

For active tags a very low cost reader, such as a mobile phone or other hand-held device, can be used, enabling tags to be read each time a porter visits a location in his normal course of duty. This can provide location information up to 10 times per day in the more frequented locations. For locations that are not visited frequently it may be necessary to request porters to visit the location merely to get asset location information.

Passive Tag

Passive tags can be encased in a protective plastic casing similar to active tags if required. However they can also be embedded in a normal label as shown in the picture below. They are much lower cost typically adding approximately 20p to the cost of a label.

A more powerful reader is required to read passive tags. Suitable hand held readers are relatively large and expensive and their read range is limited to around 3 metres. The read reliability and accuracy will vary with the power of the reader and the direction of the reader's antenna. Tag readability is affected by a number of factors including the size of the tag and the type of material on which is it placed; it is important to select the most appropriate tag from the wide range available.

Reader performance can be improved by mounting the reader on a trolley and providing it with a separate power supply and incorporating a number of antennae.

The frequency with which locations are reported will clearly depend on how often the user visits a location with the mobile reader.

17.2. Fixed readers – active tags

Here fixed readers, linked into the hospital LAN, are located in areas where assets are likely to be and where their location is required. The assets are tagged with an active, or battery assisted passive tag, which reports its identity to the reader which then reports back which tags/assets are in its vicinity.

The location accuracy is dependent on the strength of the signal from active tags and the number of readers. Readers have to be installed and linked into the network which can be difficult to manage in areas where patients are being treated.

17.3. Fixed readers - passive tags

This is similar to fixed readers with active tags except that passive tags can only report their identity from a relatively short distance of up to 10 metres depending on the reader and tag. For this reason the fixed readers are often placed in choke points, such as doors, where the distance from tag to reader is relatively short. This enables assets to be tracked into and out of rooms. It is assumed that an asset's location remains the same until it is detected passing through the same or another choke point.

Clearly the location is only definite when tags are read as they pass through a choke point. Again readers have to be installed and linked into the network which can be difficult to manage in areas where patients are being treated. However the tags are very low cost.

17.4. Wi-Fi Location

This approach requires comprehensive Wi-Fi coverage which has been specifically designed for RTLS. In particular the wireless access points for RTLS must be more carefully positioned than that required for simple data access. Assets are tagged with an active tag which uses triangulation of the wireless access points to calculate its position. It then reports its position through the nearest access point.

Location accuracy can be down to approximately 3 metres depending on the number, layout and configuration of the access points. Installing Wi-Fi for RTLS is expensive and accuracy can be

affected by equipment movement and the material of the physical building. It is difficult to get accurate room level location since Wi-Fi signals may pass s through walls.

17.5. Location Beacon

Locations have a low cost beacon device, usually infrared or acoustic which sends out a simple beacon ID signal which cannot penetrate through walls. Assets are tagged with an active tag which picks up the beacon ID signal and reports the asset ID and the ID of the beacon, which is associated with a specific location back through the nearest Wi-Fi access point. This provides an accurate, room level location for the asset.

The Wi-Fi installation only needs to be sufficient for data transfer rather than for RTLS triangulation. This approach gives unambiguous room location accuracy since the acoustic and infrared signal cannot pass through walls.

18. References

BSI PAS 55-1:2008 Asset Management

Specification for the optimised management of physical assets
http://pas55.net/

BSI PAS 55-2:2008 Asset Management

Guidelines for the application of PAS 55-1
http://pas55.net/

Coding for Success

http://webarchive.nationalarchives.gov.uk/20080814090248/dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_066082

GS1 Company Prefix Governance GS1 UK Paper for HSCIC

On request from GS1 UK

GS1 DataMatrix
http://www.gs1.org/docs/barcodes/GS1_DataMatrix_Introduction_and_technical_overview.pdf

GS1 General Specifications
www.gs1.org/genspecs

GS1 Healthcare User Group
http://www.gs1.org/docs/healthcare/GS1_HUG_ps_Camera_Based_Scanners.pdf

ISB 0108 AIDC: Automatic Identification and Data Capture
http://www.isb.nhs.uk/library/standard/196

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http://www.isb.nhs.uk/documents/isb-1077

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http://www.mhra.gov.uk/home/groups/dts-bs/documents/publication/con2025143.pdf

The GS1 GLN Allocation Rules
http://www.gs1.org/1/glnrules/

The GS1 GLN in Healthcare Implementation Guide http://www.gs1.org/docs/gsmp/healthcare/GLN_Healthcare_Imp_Guide.pdf

Recommendations on the use of GLNs in NHS Trusts GS1 UK Paper for HSCIC

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The Role of RFID in Managing Mobile Devices - Harland Simon
http://www.harlandsimon.com/downloads.php