A tertiary hospital audit of the use of medical imaging in the 24 hours preceding death

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Aim

Medical imaging is a key component of modern medical care, and progressive improvements in image quality and availability have led to a dramatic increase in imaging utilisation (1, 2). However imaging, and specifically the processes involved in procuring the images necessarily impose a degree of discomfort, inconvenience and morbidity (3) for patients, especially those who are critically ill (4). As with all medical interventions, the risks and benefits of imaging must be considered for all patients.

This study aimed to explore this further by determining the number of patients who received medical imaging in the 24 hours preceding death, which imaging modalities were used, the indication for imaging, and the patient setting (either inpatient, intensive care or emergency department). All patients recruited were patients of St. Vincent’s Hospital, Melbourne, Australia which is a metropolitan university affiliated tertiary hospital.
Methods and materials

A retrospective audit was undertaken with approval from St. Vincent's ethics committee. All patients who died over a 2 year period (01 November 2011 to 01 November 2013) as either admitted inpatients of the hospital or patients in the emergency department were selected. Patient files and data were obtained from both medical records online (MRO) as well as the picture archiving and communication system (PACS).

Time interval from imaging to patient time of death was estimated and only patients who received imaging within the 24 hour window prior to death were included in the final audit. This time interval was calculated via time of imaging which was obtained from PACS and then correlated with the time of certification of death as recorded in MRO.

Patient datasets were separated into Emergency Department (ED) patients and inpatients. Inpatient data was further subdivided into intensive care unit (ICU) and non-ICU patients. Specific data was collected for imaging completed for patients while in ICU in order to determine the extent and purpose of imaging in this particular patient group. ICU patients were differentiated in this way because frequent imaging may often be routine (e.g. daily chest X-rays (CXR) in ventilated patients), and goals of care are likely to be aiming for full reversibility with active management and support commensurate with that.

Imaging request forms were obtained from PACS and reviewed by a single medical investigator (DL), who categorised the reason for imaging into one of four categories, being 1) Line/tube positioning confirmation 2) Investigation of symptoms/pathology 3) Monitoring of disease/recovery progress or 4) Not specified/other.

Not specified/other included patients with imaging request forms that did not provide any indication as to why the imaging was being performed or other reasons including post-brain death organ donation imaging or interventional radiology.

The imaging modalities utilised were also recorded (plain film, ultrasound, computer tomography, magnetic resonance imaging and nuclear medicine).
Results

From 01 November 2011 to 01 November 2013, 1891 patients died at St. Vincent's Hospital Melbourne. 1855 were recorded as inpatients and 36 as emergency department patients. The mean age of patients in this study was 73 years old, with 874 (46%) female and 1017 (54%) male patients.

Of these, 364 (19.6%) inpatients and 14 (38.9%) emergency department patients received imaging in the last 24 hours prior to their death.

582 imaging episodes were performed for the 364 inpatients in the last 24 hours of their life. 444 (76.3%) of those were plain film requests, 92 (15.8%) computer tomography (CT) requests, 36 (6.2%) ultrasound (US) requests, 2 (0.3%) magnetic resonance (MRI) requests, 5 (0.9%) nuclear medicine (NM) requests and 3 (0.5%) interventional radiology (IR) requests (Table 1).

Of the 364 inpatients who had imaging in the last 24 hours of life, 187 were in ICU at time of their death, leaving 167 patients receiving imaging who were not in ED or ICU patients at time of their death. Of these 167 patients, 288 imaging requests were received which is 1.72 requests per patient. 199 plain films (69.1%), 64 CTs (22.2%), 20 US (6.9%), 1 MRI (0.4%), 3 NM (1%) and 1 IR (0.4%) were performed (Table 1).

Out of 364 inpatients, 187 (51%) were in ICU at the time of their death. 294 imaging episodes (1.6 episodes per imaged patient from all modalities) were performed for these patients in ICU. 245 (83.3%) were plain films, 28 (9.5%) CTs, 16 (5.4%) USS, 2 (0.7%) angiograms, 2 (0.7%) NM, 1 (0.3%) MRI and 2 (0.7%) other. Of these 245 plain films performed in ICU, 239 (98%) were CXRs. Of these 49 (20.5%) were for line/tube placement confirmation, 64 (26.8%) were for investigation of symptoms/pathology, 98 (41%) were for monitoring of disease progress and 28 (11.7%) for other indications (Table 1/Table2).

A total of 31 patients died in ED. Of the 31 patients, 19 imaging episodes were performed for 14 ED patients within the 24 prior to their death. 14 CXR's, 3 CTB's and 2 CT angiograms. Most imaging requests (95%) were for investigative purposes, and 5% performed for line/tube position confirmation (Table 2).

Considering the imaging performed for inpatients in the last 24 hours of life as a total (n=582), reasons for imaging (for all modalities) were categorised as 68 of 582 for Line placement/tube positioning confirmation (11.7%), 360 for investigation of pathology/symptoms (68.9%), 118 for monitoring of disease/progress of recovery (20.2%) and 36 other (6.2%). (Table 2)
Table 1: Imaging Modalities for Inpatients (ICU and non-ICU) and ED

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<table>
<thead>
<tr>
<th>Indications</th>
<th>Inpatient (non-ICU)</th>
<th>ICU</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain Film</td>
<td>199</td>
<td>245</td>
<td>14</td>
</tr>
<tr>
<td>CT</td>
<td>64</td>
<td>28</td>
<td>5</td>
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<tr>
<td>US</td>
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<td>16</td>
<td></td>
</tr>
<tr>
<td>MRI</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>NM</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>IR</td>
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</tr>
</tbody>
</table>

Table 2: Reasons for Imaging for Inpatients (ICU and non-ICU) and ED

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<table>
<thead>
<tr>
<th>Indications</th>
<th>Inpatient (non-ICU)</th>
<th>ICU</th>
<th>ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line/Tube Position</td>
<td>19</td>
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<td>1</td>
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<tr>
<td>Investigation</td>
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<td>124</td>
<td>18</td>
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<tr>
<td>Monitoring</td>
<td>22</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Other</td>
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<td>25</td>
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</tbody>
</table>
Conclusion

Discussion

Based upon our literature review we can find no other study examining the use of imaging preceding dying. Our study was designed to determine the incidence of imaging prior to dying and identify broad trends in use, with the hope of being able to identify any trends in hospital practice leading to over-imaging or unnecessary imaging for patients who were already critically ill.

Patients in the emergency department were more likely to receive imaging than inpatients (39.6% vs 19.6%). This is not surprising though given the nature of an emergency department presentation, specifically that these patients have likely presented in crisis with new acute or acute on chronic complaints and are undergoing a process of investigation while background history is sought. It should also be noted that this ED dataset is somewhat rarefied, since these patients presented to ED and died within 24 hours of arrival without being admitted under the care of an inpatient team. Therefore it may be assumed that they were imminently dying on presentation, with little scope for reversibility and perhaps were not well known to any of the inpatient teams. It was beyond the scope of this study to determine the impact of advanced care planning on imaging use, though some have suggested that understanding patients preferences for future care may reduce futile and unnecessary investigations for patients presenting and dying in the emergency department.

Excluding this ED group however the proportion of inpatients receiving medical imaging in the last 24 hours of their life remained relatively unchanged (364 of 1855, 19.6%). Of these 187, 51% were in ICU at the time of their death, around half of the inpatients were either presumed stable and well enough to be managed on the ward, had treatment limits in place that did not include escalation to ICU and/or were acknowledged to be dying and receiving palliative only management. Our findings found the majority of ward inpatients had imaging to investigate a new symptom or pathology, with only very few for monitoring only. While this is reassuring in part, it does perhaps suggest that the diagnosis of imminent death has not been acknowledged by the treating team. Though we did not undertake a complete chart review of cases, even if these were all new and acute complications leading to hospital protocol driven investigations for patients with clinical deterioration and unexpected death (which is unlikely); it still seems that the medical teams are missing an opportunity to acknowledge that the situation is catastrophic and irreversible, allowing the focus to shift to providing symptom relief and the essential tasks of end of life care, rather than medical imaging and, in these cases, presumably futile investigation. Monitoring the rates of medical imaging use in cases of inpatient death, is an easily measurable marker of intervention and is in keeping with the aims of a good death and dying with dignity. Recognition of death and dying
and employing appropriate care in the acute hospital environment is the subject of much active discussion (11, 12). Use of imaging is an easily performed audit, and although it has some limitations, is a good measure of how well we are doing with this process.

Patients who die in the ICU environment are, perhaps like the ED cohort expected to undergo more investigations in the last 24 hours of their life as our data suggests. However more than half of the total CXR, some 239 (55.8%), were in fact resource intense mobile CXRs undertaken daily for ICU patients, and of these 41% of them were for daily monitoring of disease progress. Some have suggested that this daily imaging may not be necessary for the broader ICU patient population (13) and given we only recorded data for those who died in the subsequent 24 hours, review of protocols and policies around 'routine' requesting in the ICU environment would seem a worthwhile and important. This is in keeping with the current push promoting dying with dignity in the ICU (14).

**Conclusion**

Medical imaging has become an integral part of most hospital practice throughout the developed world. Through technological advancements and ever increasing availability clinicians are able to obtain faster and clearer images across a broader range of modalities than ever before. However, not all patients who can have imaging, should have imaging. The decision to request imaging should not be automatic, particularly in critically ill and palliative patients, but rather should be undertaken while considering the patients goals of care and like any intervention, weighing the potential benefits against the burdens.
Personal information

**Daniel Liu**

Daniel Liu is currently working as a PGY3 surgical RMO at St. Vincent's Hospital, Melbourne. He has a strong passion for radiology and hopes to start radiology training soon.

**Jenny Weil**

Jenny is working at St. Vincent's Hospital as a Palliation Medicine consultant.

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References