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CLINICAL RESEARCH

Diagnosis and Management of Gastric Leaks After Laparoscopic Sleeve Gastrectomy for Morbid Obesity

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Abstract
Background Laparoscopic sleeve gastrectomy (LSG) is increasingly being recognised as a valid stand-alone procedure for the surgical management of morbid obesity. The leak rate from the gastric staple line ranges from 1.4% to 20%. From our experience of management of LSG leaks, we have been able to formulate an algorithm-based approach to the management of these patients.
Methods All patients referred to our hospital within a 24-month period with a diagnosis of gastric staple line leak in the background of a previous LSG were included in the study. A retrospective case note review was undertaken for these patients and an algorithm formulated.
Results There were fourteen patients in the study. There were four males and ten females. Patients were managed with a combination of laparotomy, laparoscopy, endoscopic covered stenting, percutaneous radiologically guided drainage, jejunal enteric feeding and total parenteral nutrition. In five patients, re-look laparoscopy or laparotomy with washout and drainage was performed. The remaining eight patients were managed conservatively. There were no deaths.
Conclusions Although it is often disappointing when LSG leaks do occur, with adherence to the basic tenets of the surgical management of enterocutaneous fistulae as well as early detection and a high index of suspicion, these complications can be successfully managed using an algorithm-based multi-disciplinary team approach.

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Introduction

Laparoscopic sleeve gastrectomy (LSG) is increasingly being recognised as a valid stand-alone procedure for the surgical management of morbid obesity [1]. It is effective in achieving 60–70% excess weight loss by 3 years [1]. The reported gastric leak rates from the sleeve staple line are 1.4–2.5% for primary sleeve gastrectomies and 16–20% for re-operative surgery where a previous gastric operation has been performed [2–5]. We report our experience with 14 sleeve gastrectomy leaks that presented to a metropolitan teaching hospital over a 24-month period. From this experience, we have been able to formulate an algorithm-based approach for the management of these patients.

Methods

All patients referred to our hospital with a diagnosis of gastric staple line leak in the background of a previous LSG were included in the study. The results were reviewed retrospectively.

The time period was January 1, 2007 to December 31, 2008. The total number of laparoscopic sleeve gastrectomies performed in Western Australia during this time is not known. A conservative estimate would be between 500 to 600 cases.

The patients referred to our centre came from five different surgeons in four different centres in the state of Western Australia. Practice is certainly not standardised between surgeons, and some surgeons use the harmonic

scalpel, and some use the Ligasure device. Some oversew the proximal staple line, and some do not. Some use biological (e.g. Tisseel Duo) glue to the staple line, and some do not. Some use electrocautery; some do not. Patients who have received various combinations and permutations of these techniques are all represented here. The number of patients in this study would thus be too small to come to any sensible conclusion regarding the use or non-use of these techniques. Most, however, do not test with methylene blue after the operation, and all leave a drain in at the end. The sleeve gastrectomies were all generally commenced on the greater curve 4–6 cm from the pylorus.

Diagnosis of a leak was established via contrast (Gastrografin) swallow or abdominal computed tomography (CT) scan. Examples of these are shown in Figs. 1 and 2. We have found CT of the abdomen with oral contrast more useful in the early stages as it is able to identify any undrained collections, whereas contrast swallow is more useful in follow-up to monitor the progress of the fistula. Contrast swallow was also used to establish minute leaks from the staple line which were not obvious with CT scan. Occasionally, the leak was difficult to diagnose and required either ingestion of methylene blue (5 mL in 250 mL of water) to see if any would come out into the drain or alternatively, radio-opaque contrast injected into the drain as a tubogram to see if any would enter the gastro-intestinal tract. As a confirmation, if an endoscopic procedure was planned, such as naso-jejunal tube (NJT) or covered stent insertion, the defect would be looked for at upper gastro-intestinal endoscopy.

Fig. 1 Contrast swallow showing gastric fistula after sleeve gastrectomy

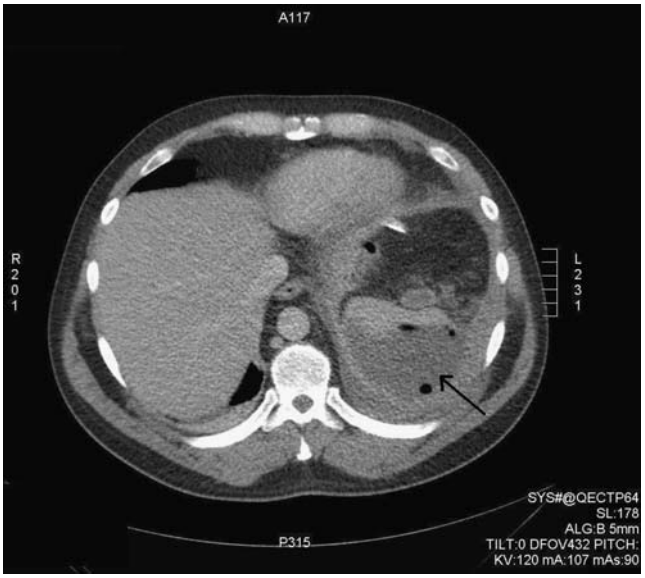

Fig. 2 CT scan showing left upper quadrant collection due to a sleeve gastrectomy leak (*arrow* points to collection)

Patients were treated according to the protocol outlined in Fig. 3a. This divides the management of leaks as to whether they were early or late and whether sepsis was well controlled or not. Sepsis was defined as fever >38°C with a raised white cell count. Corroborating evidence included tachycardia >100 beats per minute and a rising C-reactive protein. The term "primary" sleeve gastrectomy denotes patients who have not had any previous gastric surgery, whereas secondary sleeve gastrectomy denotes patients who have had previous bariatric surgery, either an adjustable gastric band or vertical banded gastroplasty. In essence, the general principles of management of enterocutaneous fistulae were applied, that is, control of sepsis, attention to nutrition, definition of the anatomy, protection of the skin around the drain and planning for definitive management. (Fig. 3b). For example, in a septic patient with an early leak, without a drainable collection, then the patient would be taken back to the operating theatre for either a laparoscopic or open washout, placement of drains, attempt at repair of the hole (if seen) with an omental patch or insertion of a T-tube through the defect if the defect was large enough to accommodate a T-tube, and a feeding jejunostomy would be performed. A feeding jejunostomy has advantages over an NJT because it is less likely to be inadvertently dislodged and is better tolerated by the patient as it obviates the discomfort of a tube protruding through one of the patient's nostrils. This is especially true because the patient may need tube feeding for a number of weeks. The term "NJT feeding" refers specifically to enteric nutrition via an NJT whereas the term "tube feeding" refers to enteric feeding either through an NJT or through a feeding jejunostomy.

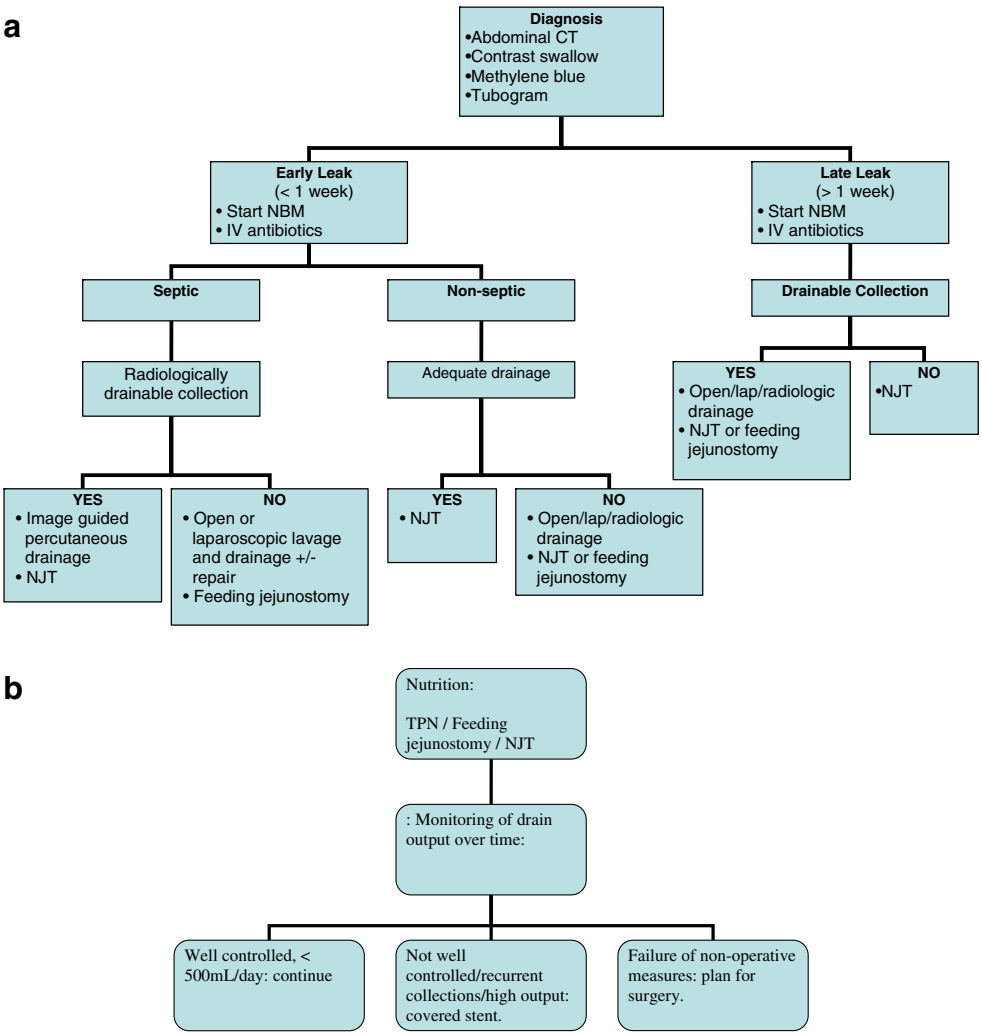

Fig. 3 **a** Management algorithm for sleeve gastrectomy leaks. Key: *CT* computed tomography, *NBM* nil by mouth, *IV* intravenous, *NJT* naso-jejunal tube. **b** Subsequent issues in the management of sleeve gastrectomy leaks: contrast swallow once drain output is at <30 mL per day, prior to commencement of oral intake, to ensure that fistula has closed

We observed occurrence of any further complications from our interventions, need for intensive care unit (ICU) stay, need for total parenteral nutrition (TPN), usage of covered stents and need for additional surgery. We have reported length of stay at our institution even though patients presented at various stages after the onset of their leak. This serves as a proxy marker for the duration of their leak, as patients were not discharged until their leak was close to or already healed.

Data were entered into a Microsoft Excel spreadsheet. A Mann–Whitney U test was used to test for statistical difference in non-parametric variables. A p value of 0.05 or less was considered as statistically significant.

Results

There were 14 patients in the study. There were four males and ten females. Ten patients had their original LSG surgery performed at another hospital, whilst four patients had their surgery performed at our institution. Eleven patients had leaks in primary sleeve gastrectomies, whereas three patients had leaks following a sleeve gastrectomy after another bariatric operation (previous vertical banded gastroplasty (VBG) in one patient and previous laparoscopic adjustable gastric band in two patients). Eight patients had "early" leaks (within 1 week of surgery), and six patients had "late" leaks after more than 1 week of surgery. Three patients required an ICU stay, and five patients required TPN at some point during their admission.

In five patients, re-look laparoscopy or laparotomy with washout and drainage was performed. The time from initial operation to final definitive operation ranged from 1 day to 1 year. However, once the diagnosis of an early leak was made in a septic patient, surgery occurred within 24 h. In one of these patients, the defect was so large (3 cm) that a jejunal serosal patch repair had to be done to close it. In the other patients, the defect was not clearly visible, and lavage and drainage was all that could be done. Certainly, a suspicion of the location of the leak could be ascertained due to the location of the most severe inflammatory response and the area where the omental fat was most

adherent to the staple line. In these cases, it was felt that it would be prudent not to peel the omentum away from where it had started to plug the defect in the staple line. All the leaks were at the proximal staple line, within 2 cm of the gastro-oesophageal junction.

Another patient developed a high-output fistula which did not heal despite 1 year of repeated surgery followed by conservative management. She underwent a Roux-en-Y oesophago-jejunostomy with the gastric remnant left in situ as it was firmly adherent to the pancreas. The remaining eight patients were managed conservatively.

Early leaks had a high output ranging from 500 to 1.2 L per day within the first few post-operative days, and this would, in most cases, gradually reduce over time. Late leaks had a lower output of 50–300 mL a day initially, and this would also gradually reduce in volume over time.

Interestingly, the average length of stay for the early leaks was 8 weeks, and it was 3 weeks for the late leaks. Overall average length of stay was 5.83 weeks. The difference between the early and late leak patients' length of stay approached, but did not reach statistical significance with a p value of 0.051.

Four patients had the Echelon (Ethicon Endosurgery, Cincinatti, USA) gold cartridges used at the upper part of the staple line and the remaining ten had Endo GIA (Covidien, Mansfield, USA) blue cartridges.

In two patients, bleeding may have contributed to the development of a leak. In one patient, intra-luminal bleeding developed 4 days post-operatively. This manifested with haematemesis and at endoscopy, there was a bleeding vessel 2 cm distal from the gastro-oesophageal junction. This was clipped and coagulated, and 2 days later, a CT scan performed for ongoing sepsis showed a large left upper quadrant collection with air in it. Gastro-intestinal contents were drained from this collection through a radiologically assisted percutaneous drain. In another patient, frank blood was noted through the drains on day 3 post-operatively, and the patient had an episode of tachycardia and hypotension. She recovered with fluid resuscitation and was continued on conservative management. However, on day 5, frank gastro-intestinal contents were noted in the drains, and it is hypothesised that a perigastric haematoma may have eroded into the stomach leading to a leak.

The two patients who needed reconstructive surgery are described in more detail here.

The first patient was a 51 year old woman who had previously had an adjustable gastric band inserted at open operation 9 years ago. This became infected and had to be removed. She subsequently presented some months after its removal for a sleeve gastrectomy. This commenced laparoscopically but had to be converted to open surgery due to bleeding around the right hiatal pillar. An open-sleeve gastrectomy was performed in the routine manner, but gastro-intestinal contents were noted in the drain on about day 3 post-operatively. As a result of high drain output, a covered stent was inserted on day 5, but this did not deploy properly as there was a kink in the upper part of the stent. She remained septic, and a CT of the abdomen showed a peri-splenic collection. She returned to theatre at day 7, and a large 3 cm defect was found in the body of the stomach in the anterior wall, and the whole upper stomach appeared poorly perfused. The stent was removed via the defect in the stomach, and the defect was closed with a jejunal serosal patch with a 16F T-tube intubating the stomach being incorporated into the "anastomosis". 28F bore drains were placed around the repair. The spleen was removed incidentally as it was damaged whilst dense; fibrinous adhesions were removed from the peri-splenic region. A feeding jejunostomy was inserted. The patient developed a small leak into the drains post-operatively, but this resolved with conservative management.

The second patient was a 53 year old woman who had a previous VBG. She underwent LSG at another hospital in October 2007. She developed a post-operative staple line leak, and despite two laparotomies for drainage and two attempts at covered stents, she continued to have a high output gastrocutaneous fistula even after a year. At one of the laparotomies, a gastro-colic fistula was noted and disconnected. She finally underwent another laparotomy where it was found that she had three breaches in her gastric staple line leading to the fistula. The back of the stomach was firmly adherent to the pancreas. As such, a decision was made to disconnect the oesophagus from the stomach, perform a Roux-en-Y oesophago-jejunostomy and intubate the holes in the stomach with T-tubes. The proximal stomach was stapled off and oversewn. The patient developed a small leak at the oesophago-jejunostomy, but this settled with conservative management.

These two patients were able to be discharged home on a soft diet, and although both developed small leaks at their joins, this is not surprising given that these were essentially performed in an infected field in nutritionally depleted patients.

Covered stents were used in eight patients. Roughly 1 week would elapse before insertion of a covered stent. This allowed time for us to note the output from the drains and for the gastroenterologists to arrange the procedure. The stents had to be removed prematurely due to a problem with the stent in four patients. In two patients, the stent had to be removed for migration, in one because of haematemesis and in one because the stent did not deploy properly and was kinked at the top end. In the remaining four patients, the stent was able to be left in for 6 weeks, and the fistulas closed spontaneously as a result. Thus, the main

complications relating to the use of the algorithm related to use of covered stents. There were also two wound infections that occurred in patients who had open surgery.

It was also common to develop a sympathetic left pleural effusion in these patients, and four of our patients required formal drainage of the left thoracic cavity with an intercostal catheter (ICC). In one patient, due to a loculated empyema, three doses of 250,000U of streptokinase had to be given through the ICC in order to dissolve the fibrinous septations within the collection and lead to resolution of the empyema.

There have been no deaths in our series so far. The results are summarised in Table 1.

The presentation and management of early and late leaks were found to be quite different.

Early leaks presented with severe left upper quadrant pain of sudden onset radiating to the left shoulder. If the patient was still in the hospital with drains in, then, either pus or gastro-intestinal content was noted in the drain. If the patient was at home, then fever, nausea and vomiting usually accompanied the pain. The diagnosis was usually made by either CT scan of the abdomen or contrast swallow, and the algorithm in Fig. 1 was followed. Placement of a feeding jejunostomy at the time of re-operation is crucial in minimising the use of TPN.

Late leaks, on the other hand, were usually of a more insidious onset with gradual increasing left upper quadrant discomfort and nausea, with or without a fever. Diagnosis was usually on CT scan of the abdomen showing locules of free air and a collection around the upper part of the gastric staple line, often extending around the spleen. These were usually managed with nil by mouth (NBM), intravenous antibiotics, NJT and tube feeding or covered stent, plus radiological drainage of any drainable collections.

Discussion

The management of laparoscopic sleeve gastrectomy leaks is challenging and resource intensive. As more and more sleeve gastrectomies are done worldwide, the number of leaks encountered will undoubtedly increase. It is important to have a systematic, evidence-based approach to the management of these leaks, which is why we are presenting our experience here, in order to contribute to the available literature. At the time of writing, there are no other articles in the literature focusing on the management of laparoscopic sleeve gastrectomy leaks.

It is important that patients are treated in a centre with full intensive care, gastroenterological and radiological back-up.

From our experience, we have developed an algorithm for the management of these patients as seen in Fig. 1. Patients usually present with greater signs of sepsis, in the form of fever at temperatures >38°C, raised white cell count and tachycardia greater than 100 beats per minute, in the early leaks, and thus drainage of infected collections is a greater priority in these patients. Even patients without obvious collections who present early require return to theatre, and at least a laparoscopic washout because of overt signs of sepsis and because of the early presentation, the septic effluent may not be walled off as a discrete collection in patients who leak in the early post-operative period. Thus, even though a CT scan of the abdomen may

Table 1 Summary of patients

Patient number	Age	Gender	Primary	Early/late	Surgery	ICU	TPN	Stent	Dx	LOS (weeks)
1	64	M	Y	E	N	Y	Y	N	CT	13
2	34	F	Y	E	Y	Y	N	N	CT	3
3	26	M	Y	L	N	N	N	S	CT	2
4	33	F	N	E	Y	N	N	SR	CT	9
5	53	M	Y	E	Y	N	Y	S	Sw	8
6	46	F	Y	E	Y	Y	Y	SR	E	14
7	49	F	Y	L	N	N	N	N	T	3
8	53	F	N	E	Y	N	Y	SR	Sw	11
9	30	F	Y	L	N	N	N	N	CT	4
10	28	F	Y	L	N	N	N	S	CT	4
11	48	M	Y	L	N	N	Y	S	Sw	4
12	51	F	N	E	Y	N	N	SR	CT	5
13	60	F	Y	L	N	N	N	N	CT	1
14	43	F	N	E	Y	N	N	N	CT	1

M Male, *F* female, *Y* yes, *N* no, *E* early, *L* late, *S* stented successfully, *SR* stent had to be removed for complication, *Dx* diagnosis made by, *CT* computed tomography scan, *Sw* contrast swallow, *E* endoscopy, *T* tubogram, *wks* weeks

not show a discrete collection, these patients show signs of sepsis due to the gastro-intestinal contents bathing their peritoneal cavity, and they therefore require at least an operative lavage and placement of drains. Those presenting late, may or may not have significant collections which need drainage. In general, collections less than 5 cm in diameter (about 65 mL) in patients that were not overtly septic were treated without drainage. We do not advocate direct surgical closure of defects if seen during the laparoscopy or laparotomy as the tissue is often friable due to inflammation and edges often ischaemic. However, on a number of occasions, we have managed to insert T-tubes or Foley catheters through these defects with partial purse-string closure around them to achieve controlled fistulae with success. It is important that nursing staff are instructed not to put anything down the balloon lumen of the Foley catheters as a couple of patients had their Foley catheter balloon "inadvertently" inflated to 10 mL by well-intentioned nursing staff on the ward. The patients manifested as proximal gastro-intestinal tract obstruction with severe nausea and vomiting until the balloon was deflated. T-tubes are classically used to create controlled fistulae from the common bile duct after bile duct exploration or in managing the oesophageal tear in a Boerhaave's syndrome. These descriptions can be found in any good general surgical textbook. They work well in other parts of the gastro-intestinal tract as well and are advocated in manoeuvres such as diverticulisation of the duodenum in the management of duodenal trauma. It is also common practice to use a T-tube or Foley catheter to intubate proximal enterotomies or anastomotic leaks where there is marked peritoneal contamination and a proximal diverting stoma would not be a good idea due to high output. The use of a T-tube or Foley's catheter to intubate the defect in a sleeve gastrectomy leak is just an extension of these well-established and accepted principles. Drains still need to be placed in the peritoneal cavity around the T-tube as there is invariably a small amount of leakage around the tube.

Patients with early leaks who show signs of systemic sepsis should be taken back to theatre for a laparoscopic washout. The aims of this surgery are threefold: firstly, washout of contaminated peritoneal fluid or collections with copious amounts of normal saline; secondly, to establish adequate drainage by placing more numerous or larger drains around the gastric leak site and other likely areas of fluid collection such as above the spleen and thirdly, to establish an enteric feeding route preferably through a laparoscopically inserted feeding jejunostomy. We have found that by moving the ports to a lower level in the abdomen and using 2/0 vicryl sutures, a feeding jejunostomy can be safely inserted laparoscopically.

However, a laparotomy may be mandated if laparoscopic access for the washout and placement of drains is poor due to swelling and inflammation of the surrounding tissues.

Following control of sepsis with drainage and antibiotics (which often will have to be administered long term), the next priority is that of nutrition. As alluded to earlier, a surgically inserted feeding jejunostomy reduces the need for total parenteral nutrition, but failing this, naso-jejunal feeding through a radiologically guided placement of a naso-jejunal tube allows enteric feeding past the internal opening of the gastric fistula. TPN is reserved as a last resort as it is prone to complications such as infection of the central line and derangements in liver function tests.

We avoid insertion of foreign material such as mesh or glue into the fistulous tracks as we feel that any foreign material would impede rather than assist with healing of the fistula.

Our experience with covered stents has not been as encouraging as published in the literature [6]. We now reserve covered stents for use in patients who have failed to settle with other methods of management.

Last resort, salvage surgery should also be in the armamentarium of the treating surgeons. In our experience, one patient required a jejunal serosal patch to the defect, and another eventually required disconnection of her oesophagus from her stomach and a Roux-en-Y oesophago-jejunostomy. The literature has reported a case of a jejunal Roux loop being brought up to an established fistula with success [7]. However, the two approaches which we have described here have not been, to our knowledge, previously described for this condition.

The overall numbers in this study are small, but this is the largest series of LSG leaks to be published, as our institution is in the unenviable position of being the major referral centre for bariatric complications in our state. This is also a retrospective study, and the algorithm will need to be tested in a prospective manner to ascertain its validity and applicability in the management of the spectrum of LSG leak presentations.

There is some debate in the literature about the utility of reinforcement of the staple line with either buttressing materials (e.g. Seamguard) or sutures. None of the patients we report had buttressing material, and three of them had suturing of the proximal staple line. The literature appears to support use of buttressing material to reduce post-operative bleeding from the staple line but there does not appear to be any evidence to suggest that it reduces staple line leaks [8, 9].

Although it is often disappointing when sleeve gastrectomy leaks do occur, with adherence to the basic tenets of the surgical management of enterocutaneous fistulae, as well as early detection and a high index of

suspicion, these complications can be successfully managed given the right multi-disciplinary team approach, involving radiologists, gastroenterologists, microbiologists, intensive care physicians, anaesthetists, surgeons, dietitians, occupational therapists, social workers and physiotherapists.

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